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ELECTRICAL PRODUCTION IN 1902.

A study of the figures of electrical production during the past ten or twelve years would indicate a steady average yearly increase of about 20 per cent. in the amount, or value, of manufacturing done. In fact, such a rate, strange as it may appear, would go back as far as 1880. In that year the U. S. Census returns showed a product reported of $2,655,036. Ten years later the amount reported was $19,114,714, evidencing that a slightly higher increase than 20 per cent. had prevailed. The figures for the U. S. Census of 1900 showed, for all the concerns that should be properly included, a total just short of $105,000,000 for the year ending June 30, 1901. An industry which throughout twenty years, good, poor, and very bad, could maintain an average rate of 20 per cent. increase, or thereabouts, is entitled to consider itself pretty firmly established, with a future full of hope as to the next ten years.

There is no doubt that since the 1900 Census figures were compiled, the rate of growth in production has been kept up, on the average, while in many branches of electrical activity it has been accelerated, as, for example, in the output of motors and in the extension of telephonic work. Below is given a table of probable production in the various lines for 1902, based on the statistics of 1900-1, showing a gross estimated total of about $140,000,000 in round figures:

ESTIMATED PRODUCTION, 1902.

Dynamos	$14,500,000
Transformers	4,000,000
Switchboards, for lighting and power	2,450,000
Motors, for all purposes	27,000,000
Storage batteries	3,000,000
Primary batteries	1,250,000
Carbons	2,000,000
Arc lamps	2,100,000
Incandescent lamps	5,000,000
Lighting fixtures	3,500,000
Telephonic apparatus	21,000,000
Telegraphic apparatus	1,750,000
Insulated wires and cables	27,500,000
Conduits, interior and underground	1,500,000
Rheostats, heating and cooking apparatus	2,250,000
Annunciators	250,000
Electric clocks	150,000
Lightning arresters, fuses, etc.	750,000
Measuring instruments	2,500,000
Miscellaneous apparatus	17,500,000
	$139,950,000

There seems to be no good reason for questioning the general validity of these figures, in which the items with the largest percentages of increase are those relating to motors and telephones; while insulated wires and cables being necessary to every branch of the business, except wireless telegraphy, show an equivalent great gain, sharing also in the activity of both fields in particular. The contrast between telephony and telegraphy is most striking and actually pathetic. It has even been claimed that Chicago alone produced $20,000,000 of telephonic apparatus in 1902, but that statement cannot be substantiated. As to storage batteries, it may be noted that the total product of the largest producer for 1901 was $3,300,000; but the demand for automobile cells can hardly have been as large in 1902. However, the battery figure is decidedly conservative, as the fact just mentioned will indicate.

It will be readily understood, of course, that the output of apparatus does not reveal the whole scope of electrical industrial advance. That is but one part of the story. Upon this apparatus depends the creation of new lighting plants, street railways, telephone exchanges,

etc., out of which springs a vast capitalization, based upon real estate, pole lines, tracks, franchises, etc. as well as upon equipment. The increase in street railway capital obligations for 1901-2 reached no less than $475,000,000, not estimated, but actual. No such data exists for electric lighting, but the capital in that branch easily increased $150,000,000; while it has been reckoned that the telephone art should be credited with at least $100,000,000 all told, for the year. Here we have for three branches of electricity alone close upon $750,000,000 added to the national development and investment. Moreover, while some lines of development may be less active or inert, as, for example, electric automobiles, newer ones are very busy and progressive. Such a case is that of wireless telegraphy. Another is telpherage, of which an increasing number of systems for aerial motor transportation along wires of freight, raw material, ashes, etc., are being installed. Then, again, electro-chemistry and electro-metallurgy are undergoing enormous advance, whether in such old departments as refining copper or in such new ones as making graphite or obtaining nitrogen from the atmosphere.

As to export trade in 1902, there is every evidence that it was excellent, and our weekly figures may be referred to as demonstrating a steady demand all over the world. It appears that during the ten months ending October, 1902, the value of electrical instruments exported was $3,446,966 as compared with $1,322,034 in 1901. That is a very healthy showing. Of electrical machinery in the same period there was exported $2,586,754, as against $2,081,820. This again is satisfactory, and it goes without saying that such a trade is worthy of very careful and assiduous cultivation.

THE CHICAGO TRANSPORTATION PROBLEM.

The chairman of the Committee on Local Transportation of the Chicago City Council has made public a synopsis of the report of Mr. Bion J. Arnold on the Chicago urban transportation problem, a reprint of which will appear in our issue of next week. The report fully justifies the confidence placed in the engineering ability and judgment of Mr. Arnold by those who selected him for the task of devising a remedy for the intolerable transportation situation now existing in Chicago. As might have been anticipated, no remedy is offered involving radical measures, the recommendations being for gradual ameliorations, and a choice of several plans is offered. The necessity of taking into account local conditions naturally renders a considerable part of the report of merely local interest. Of the broader aspects of the question, the principle of a single fare for a city ride is unreservedly recommended, and a choice is presented between two underground systems, one involving the use of low-level tunnels—for which preference is expressed—and the other contemplating high-level subways. Either of the above plans forms part of a general one which comprises all of the present lines within the city limits, with such extensions and new lines as are necessary to form a unified, combined surface and subway system entirely adequate to the present needs of Chicago, and admitting of expansion to meet future needs. Within the thickly inhabited part of the city the recommendation is that the cable and overhead trolley systems be superseded by the slot conduit system; the use of the overhead trolley elsewhere is disposed of with the remark that is an esthetic and not engineering question. The estimated cost of the entire system, including the value of present lines on the basis of their construction anew at the present time, is $90,000,000 with deep-level tunnels, and $5,000,000 less with subways. The report makes no recommendations as to municipal operation or ownership, but offers in several connections alternate plans for the present condition of divisional ownership and operation, for joint use of tracks under divisional ownership, and for unified ownership and management.

SYNCHRONOUS IMPEDANCE AND STANDSTILL IMPEDANCE.

The article on page 13 by Messrs. Townsend, Freund and Reich describes some measurements showing the difference between the synchronous impedance and the impedance at standstill, of certain alternators. In the case of direct-current generators, driven at constant speed, the fall in voltage at machine terminals which occurs under load, is almost entirely due to the armature resistance. The fall is, for all practical purposes, simply an IR voltage drop; where I is the current strength in amperes delivered by the generator, and R the total resistance in ohms of armature winding, brushes, series field and connections. In the case of alternators, either single-phase or polyphase, the drop of pressure at terminals under load, is considerably greater than that due to the resistance, r, of the armature. It is, however, such a drop as would be approximately accounted for by attributing a certain impedance, z, in ohms, to the armature and its connections. This equivalent impedance is commonly called the synchronous impedance of the generator.

The synchronous impedance contains a resistance, r, and a reactance, x. The reactance is so much greater than the resistance that the latter may usually be ignored, and the drop in the alternator, at constant speed, may then be approximately attributed to the synchronous reactance, The synchronous reactance, x, may, in its turn, be regarded as the product of an inductance, L, and the angular velocity, a, or 2 times the frequency. This virtual inductance of the alternator is sometimes called the synchronous inductance. The synchronous inductance of an alternator, or the inductance it appears to have when running at constant speed, in order to account for the terminal drop of pressure under load, is not the same as the inductance of the armature at rest; or the inductance it possesses, regarded as a choking coil, when at standstill, and traversed by an alternating current from an external source. If we call the inductance of the armature as measured under those conditions, its true inductance, then the synchronous inductance is always greater than the true inductance.

The true inductance of an alternator armature is not a rigidly definite quantity. The inductance of a coil of insulated copper wire, devoid of an iron core, is a fairly definite and accurately measurable quantity. The inductance of an alternator armature varies, however, with the angular position of the armature with respect to the field. It is, therefore, a cyclically varying quantity in regard to the revolution of the armature. It also varies to some extent with the strength of the current by which it is measured. Nevertheless, a mean value of the true inductance can be determined with a limited degree of precision. The synchronous inductance is always greater than this true inductance. The principal reason for the discrepancy between the apparent inductance of the armature at synchronous speed, or synchronous inductance, and the true inductance, is due to the armature reaction on the field; whereby the m.m.f. of the armature coils oppose the m.m.f. of the field coils and reduce the total excitation. The reduction in excitation produces a drop in voltage over and above that due to the true inductance. The synchronous inductance of an alternator may, therefore, to a first approximation, be regarded as the sum of the true mean inductance of the armature, as measurable at standstill, and a spurious or virtual inductance of demagnetization, or armature reaction on the field.

The measurements of Messrs. Townsend, Freund and Reich are shown to have been made for the purpose of determining, in the case of certain particular alternators, what share of the terminal drop of pressure under load was attributable to the true mean inductance as measured at standstill. They show, among other things, that the terminal drop in a machine at the very low power-factor of 40 per cent., would be rather more than twice as great as the true

inductance would account for. That is to say, the particular 5-mw, three-phase alternator at full rated mv-amps and 40 per cent. power-factor would have an inherent regulation of about 25 per cent., or would have a terminal drop of pressure under constant speed and excitation of 25 %; whereas the drop in pressure attributable to true mean inductance would not be more than 10 per cent. The extra drop of pressure would be, therefore, mainly attributable to armature reaction. Among the points of interest elicited by the measurements is the diminution in the true inductance of the armature by the excitation of the field magnets. This brings about an approach to saturation in the magnetic circuit and diminishes the flux established by the armature current, and therefore, the armature inductance.

THE OUTLOOK.

Aside from Marconi's great accomplishment of transatlantic wireless telegraphy—which was somewhat discounted, however, by the celebrated letter "S" message of a year previous—the past year has witnessed no radical developments in the department of electricity. There has, however, been a steady and solid advance in almost every branch, and lines along which future development will proceed have been more clearly marked. In electrical science the period has been one of patient investigation of the kind that does not bring great fame, but which furnishes the invaluable material for future generalization. The most promising work with respect to probable future results has been in the fields of radioactivity and electrochemistry and in connection with the ionic and corpuscular theories. We have perhaps nearly reached the moment for the appearance of a great generalizing mind that will illuminate the existing darkness of fundamental electrical theory, which has become more and more obscured to the student by the introduction of concepts bearing a likeness to the fluid hypotheses of the eighteenth century, and the speculative theories as to matter of the Greek and Roman philosophers. The task set is indeed a difficult one and comes within the sphere of physical chemistry rather than that of electricity. The solution, moreover, will be one of general application to many branches of science. In fact, we appear to have reached a stage at which the ultimate problems of the various branches of science are becoming more and more nearly related, and their nature is such that almost all can be brought into the jurisdiction of the new department of physical chemistry, there to be considered by workers of a special training and not narrowed to the knowledge of any one branch.

In the industrial branches, the new year starts with a number of tendencies more or less marked. In electric lighting the alternating current will soon reign supreme, the foothold given it in large cities for transmission purposes having been a deadly stroke at the direct current. There is much promise that the work now being done in Europe in connection with self-starting, single-phase motors, such as the Heyland motor, will soon have successful results, and then we may expect to see the direct current relegated ultimately to electrochemical work. The recent introduction in Chicago of polyphase transformers is probably the first step toward the abandonment of multiple single-phase transformers in polyphase circuits—a much wished-for consummation. In arc lighting the enclosed arc begins the year absolute victor over the open arc, but with a new foe coming into sight—the flaming arc from composite carbons. The Nernst lamp has definitely established its claims to consideration as a factor in electric lighting, and the vapor lamp looms in the future with an evil portent for the filament incandescent lamp, which, for years remaining practically stationary in development, is handicapped by the law of progress that what does not advance, recedes. From both the commercial and engineering standpoints, the most interesting development in the central station field promises to be a great extension of district electrical supply. With 12,000 volts as practicable a pressure as 1,000 volts five years ago, it is somewhat surprising that the movement has not been more rapid toward the replacement of numerous small and struggling central stations by a single generating plant with sub-station supply to the former local circuits. Within the past year descriptions of several such systems have appeared in our columns—in one instance the supply of 35 towns from one generating plant. The engineering is so simple, and the promise of financial return so excellent, that a general reconstruction of central station supply along these lines cannot long be deferred, In the field proper of power transmission, the new year opens with 40,000 volts as conservative practice and a range of operation over a distance of more than 200 miles. It is not likely, however, that water power transmission can continue to count on unrestricted development and extension. The older steam engineers have given the water wheel a wide berth, but with the advent to its ranks of a younger generation educated in the same school as those who now dominate in every branch of the electrical industry, and to whom this industry owes its militant vigor, we may expect that the possibilities of the steam engine plant for power transmission generation will not remain much longer untried. This prediction can be made with less hazard in view of the entry as factors of the steam turbine and the forces connected therewith.

Even less than a year ago alternating-current traction was under a strict taboo in this country, yet the present year will witness the trial of three such systems—the Arnold in Michigan, the Lamme in Maryland, and the Ward Leonard-Oerlikon in Switzerland, each of these, moreover, involving the use of single-phase current. Should the trials prove successful—or even any one of them—some engineering reputations will be smirched, but interurban traction will be revolutionized, an enormous impetus given toward the electrification of the shorter steam railroads of the country and even electric trunk service rendered a possibility. Telephony during the past year has continued to benefit from the reawakening brought about by the independent movement, the result showing in improvements in detail in every part of the art and in its engineering. A recent test of the Pupin system in Germany furnished for the first time public data as to its practical merits, which data fully confirm the claims made for the system. It is to be hoped that the owners of the American patents will soon see fit to allow the public to share in the benefit which the German experiments showed may be derived from the application of the invention. Aside from the purely commercial achievement of a Pacific cable, telegraphy as practised has remained at a standstill, and it promises no advance in the present year or in the years after if it remains dependent on those who now control the situation. There has, however, been no slackening in invention, notwithstanding the almost hopelessness of proximate reward. As a consequence, when the telegraphic sleep of a half century or more has its inevitable awakening, there will be no lack of material upon which to base a complete reorganization. Another branch that has lagged is that of electric automobilism, which is equivalent to saying that the long-sought-for radical improvement in light-weight storage batteries has not yet materialized. The promise of an Edison battery is still held forth, and it is reasonable to expect that with the expiration in March of the controlling Brush patent a brighter situation will exist, not only with respect to further inventions, but in the utilization of some of the many hundreds that have rested under the ban of the Brush patent. Transatlantic wireless telegraphy having been proved a possibility, it is now on the eve of the commercial stage, and with a commercial future very difficult to forecast. The next step is that of syntonic wireless telegraphy, which involves a stride even greater than that of transatlantic telegraphy for its practical accomplishment.

Landing the American End of the Commercial Pacific Cable.

One of the most interesting and important events in electrical history during 1902 was the virtual completion of the California-Honolulu section of the Commercial Pacific Cable, and the landing the shore end last month at San Francisco. It is somewhat singular that just fifty years should have passed in ocean telegraphy before the plans to cable the Pacific were pushed to a conclusion; and not less singular that Americans and Englishmen have been engaged in a generous rivalry thus to complete the submarine cable girdle around the earth. While it was to be expected that England, with her vast colonies and dependencies, would insist on having actually or virtually a system of her own, it was not less apparent that American ambitions in regard to the Far East would be unsatisfied unless a cable system also started from the California shore stretching away to the Sandwich Islands, the Philippines, and other Asian points of deep interest to us. Through the energy and enterprise of the Pacific Commercial Cable Company, American hopes have now been realized, and we now illustrate on this page the scene of the landing of the shore end of their cable at San Francisco, on Sunday, December 14, in the presence of an enthusiastic crowd of 30,000 or 40,000 people.

The point selected for the landing of the cable lies about half a mile south of the famous Cliff House, which can be easily seen on the right background of the scene. From this landing place seven miles of underground conduit carry the cable and other wires to the offices of the company in San Francisco. Among those present on the occasion were President Clarence Mackay and Vice-President George G. Ward, the latter of whom can easily be picked out in the engraving by his tall, lithe figure and active participation in what is going forward. Governor Sage, of California; Mayor Schmitz, of San Francisco, and a number of distinguished citizens also assisted at the function. An address was delivered by the Governor, and his daughter, Lucille, christened the splice.

During a reception at the Palace Hotel in honor of Clarence H. Mackay and others of the management of the Commercial Cable Company, Governor Gage represented the State, and Mayor Schmitz was present on behalf of the municipality. Mr. G. G. Ward said: "The length of this cable will be three and one-half times greater than any Atlantic cable. When this shall be completed our system will reach from England and France to China, three-fourths of the distance around the globe, and I venture to predict that we shall be able to beat 'Puck's' prophecy of girdling the earth in forty minutes by sending a message from San Francisco to San Francisco in one-fourth of that time." Meantime the "Silvertown," which started with about 2,200 miles of cable, laying it across an ocean nearly three miles deep, has proceeded with her task, completing the first great section to Honolulu.

The Philippine section is expected to be complete early in 1904. The Hawaiian landing is on the island of Oahu, with direct connection to Honolulu, where an office has already been prepared. It may be noted that in his recent presidential message to Congress, President Roosevelt alluded to the contract and conditions between the Government and the Pacific Commercial Cable Company, under which "an all-American line between our Pacific Coast and the Chinese Empire, by way of Honolulu and the Philippine Islands, is thus provided for." The cost of the first section to Honolulu is put at $2,250,000. Messages to that point will cost 50 cents a word for the first two years and 35 cents afterwards.

LANDING SHORE END OF PACIFIC COMMERCIAL CABLE, NEAR SAN FRANCISCO.

Wireless New Year Greetings Across the Atlantic.

Wireless dispatches have been received, containing Christmas and New Year greetings, in Italy from Mr. Marconi, who, at Glace Bay, sent his compliments to the Italian Minister of Marine, Vice-Admiral Morin, and to the mayors of Rome, Florence, Milan and Bologna. Among the distinguished persons who have received messages are the Queen of Italy, Empress Eugenie, Sir John Lane, and Heniker Heaton.

The storms and gales of the past two months, Marconi stated, had no effect whatever on the transmission of messages. Referring to the commercial future of wireless telegraphy, he said that he expects to be ready for commercial business between Cape Cod and Table Head within a very few months. As to rates, it is expected to transmit cheaper than is called for in the contract, which specifies ten cents a word for ordinary and five cents a word for press messages. The distance from Cape Cod to Cornwall is about 600 miles greater than from Table Head to Cornwall, but Mr. Marconi has no doubt of success. "I never doubted the practicability of my undertaking after my achievement at St. John's, Newfoundland, last winter, but on November 9th, when the *Carlo Alberto* arrived in Sydney and I first visited the Table Head station, I received full confirmation of my hope, for on entering the power house I heard ticks from the receiver, three faint dots signifying the letter 'S.'

"This signal was repeated and was louder the second time. This was the signal I had agreed on with my operator at Cornwall, and it assured me of the success of the Table Head station, for as the Morse code is made up of dots and dashes, and as it is just as easy to receive a dash as a dot, it would have been as easy at that time to receive a message. My work between that day and last Sunday was chiefly installing new machinery and making improvements and strengthening signals."

In concluding Marconi stated that he expected that wireless communication would be established with South Africa soon after a station there was opened for communication. This will give the Marconi Wireless Telegraph Company communication with all parts of the world. A banquet was given to Marconi by the citizens of Sydney on December 30.

The First Three-Phase Power Transmission Plant in Europe Operating at 30,000 Volts.

BY DR. H. BEHN-ESCHENBURG.

THERE has been in uninterrupted operation for the past two years, at 30,000 volts, the power transmission line of the Machienenfabrik Oerlikon, between Hochfelden and Oerlikon, which is the first installation of its kind in Europe, and was operated at 15,000 volts between the years 1891 and 1900. Now that this trial period has come to an end, it may be of interest to collect the valuable and unique experiences gained by the operation of this transmission, the first one in Europe using so high a pressure.

The total mean energy, delivered by the primary stations at Hochfelden and Glattfelden, working in parallel, is 550 k.v.a., with a power factor of 0.85. The power station at Glattfelden is located about 2 km from the Hochfelden station and furnishes about 120 k.v.a. at 5,000 volts to Hochfelden, where the current is raised to 30,000 volts and is connected in parallel with the current generated at Hochfelden. The exciters of the Glattfelden generators are regulated at Hochfelden.

FIG. 1.—INTERIOR VIEW OF HOCHFELDEN STATION.

The Hochfelden station, Fig. 1, contains three turbines connected to three generators of the "Lauffen" type of the Oerlikon Company, constructed in the year 1891. Each machine has a capacity of 1,200 amperes at 100 volts, at a speed of 187 r.p.m. and 50 periods. Each machine is direct-connected to a three-phase transformer of the same type as those shown at the Frankfurt exhibition in 1892 for the Lauffen-Frankfurt transmission line which has been frequently described. The transformation ratio of each transformer is 1:154. During normal running of the plant two generators and two transformers are operated. The high-tension winding of the one transformer is connected in star fashion, while the high-tension coils of the other transformer are separated for each phase and connected in series with the coils of the first transformer.

These transformers are, as is well known, standing in cast iron casings filled with oil. The oil is continually pumped into and out of the casings by means of a pump, being cooled during this operation by passing through coils surrounded by running cold water. The transformer which transforms the current delivered by the Glattfelden station, is an ordinary air-cooled transformer with a ratio of 1:6, transforming the voltage from 5,000 to 30,000. The neutral wire of the low-pressure winding is connected to the water pipes.

The line consists of four copper wires 4 mm in diameter, which are suspended about 50 cm apart on 260 poles from 8 to 10 m above the ground. Only three wires are in actual service. The resistance of one wire is 31 ohms. About 1.5 m below these wires, on the same poles, the two telephone wires (going and return), connecting the primary and secondary stations, are suspended. These two wires are crossed about 20 times along the entire distance. During the operation of the line no difficulty is experienced in carrying on a telephone communication. In case there is any fault in the insulation of the high-tension line or the telephone wires, the bells of the telephone are automatically operated on account of the disturbance in the symmetry of the electrostatic distribution and in this way the telephone is of service in case there are such defects. At the beginning, end and in the middle of the line, there have been placed for the past three years three Siemens lightning arresters (of the horn type) having a striking distance of 55 mm. These horns are operated almost every time there is a thunderstorm in the vicinity of the line, without ever having caused any interruption in the service. In fact for several years there has never been a decided service interruption, regardless of the fact that the line is run along the banks of a river and is exposed to frequent lightning discharges. There are an average of about 50 such occurrences, which strike the line, in one year. Since the plant was started no part of the transformers has ever been damaged by lightning. This certainly proves the great efficacy of high-tension lines with transformers inserted between generator and line. The much higher pressure which can be obtained by this arrangement when compared with the direct gen-

erator production, can in many cases equalize the extra cost of the transformers on account of the saving in line copper. In general this will also cause a reduction in the cost of generators, for the generator pressure may be selected at will, especially when bar winding can be employed.

The line is connected to the transformers in the primary station by fuse wire 1 m in length and freely suspended in the air. Formerly lightning rod points with copper leads were attached to each pole. Frequently during a thunderstorm lightning would strike across from the insulator support to lightning rod lead and the pole would be burnt. Two years ago all the lightning rods were removed. The 800 line insulators are of different types. About 100 of them are of the large Delta bell type, with an external rim diameter of 25 cm; there are 300 white porcelain insulators, like those used on the Lauffen-Frankfurt line; also 200 brown insulators of the same dimensions and 200 smaller plate-shaped insulators. The various types are shown in Fig. 2, the three smallest ones being used for interior wiring in the stations.

The secondary station may be cut out of service at full load by means of a high-pressure switch without the production of a spark. The switch is shown in Fig. 3 and is of the well-known type introduced by the Oerlikon Company in 1897. The spark distances are spanned by tubes. To prove the utility of this switch it may be stated that at 3,500 hp the three-phase circuit at 3,800 volts pressure may be opened without the least disturbance.

In the secondary station the line current is transformed from 30,000 to 230 volts. Up to about a year ago the transformation took place in four transformers of the 1891 type, similar to those in the primary station, two being connected in series on the high-tension side. The oil was circulated through water-cooled coils of pipe outside of the transformer by means of a pump. During the past year the old transformers have been replaced by 3 single-phase transformers of 150-k.v.a. capacity each, which have been connected in triangle fashion on the high and low-tension sides. These transformers, shown in Fig. 4, are also placed in oil, the latter being cooled, however, by being circulated through water-cooled coils within the transformers themselves. Without the water cooling the temperature rise at a 100-k.v.a. load is 35° C. Within a short time the transformers in the primary station will be replaced by a modern three-phase transformer of 450 k.v.a capacity with artificial air-cooling attachment. The new transformers shown in Figs. 5 and 6 are so wound and insulated that the same may be cut into and out of the circuit at 50,000 volts and tests made at this pressure. The difference between the old and new transformers gives a striking picture of the progress made in transformer design during the past decade. The following comparative table may, therefore, be of interest, but it should be remarked that the new transformers were built mainly with the intention to economize space and not to attain the highest efficiency. The efficiency of ordinary transformers of this size is between 98 and 98.6 per cent.

	Old type.	New type.	New type.
Capacity	200 k.a.v.	150 k.v.a.	450 k.v.a.
Total weight	4700 kg.	2200 kg.	3800 kg.
Copper weight	1540 kg.	200 kg.	450 kg.
Sheet iron weight	900 kg.	680 kg.	*2500 kg.
Oil weight	500 kg.	650 kg.	...
Oil tub weight	1700 kg.	560 kg.	...
Efficiency	97%	97.2%	97.6%
Iron loss	3400	2200	6500
Copper loss (measured at short circuit	3000	2000	4800
Maximum drop of pressure	17%	3%	3%

* The high sheet iron loss is due to the employment of standard size sheets intended for greater capacities.

The low-tension terminals of the secondary transformers are connected to busbars in parallel with the leads from a 600-kw generator, direct-connected to a Sulzer steam engine, making 97 r.p.m. The generator, Fig. 9, has an externally revolving field ring, with 64 poles and coils, which also serves as a fly-wheel and driving wheel around which the ropes pass. The efficiency of the generator is 95 per cent. The ropes are connected to two direct-current generators, producing current for lighting. In order to insure an efficient parallel working of the current delivered by the line and that of the generator, the construction of the latter had to be such as to permit of a comparatively large drop of pressure of the generator current, as the total variation of pressure of the transmission between no load and full load is about 100 per cent. Without any variation in the speed of the turbines and generator excitation, the pressure at the low-tension terminals in the secondary station was twice as great at no load as at full load, as long as the old transformers were in operation in the two stations. With the new transformers the variation in pressure will be about 30 per cent. less. The generator, coupled to the steam engine, has a pressure variation of 40 per cent. between an inductive full load and no load. The paralleling works without difficulties under these conditions. The pressure regulation is extremely simple, because neither the generator excitation nor the speed of the turbines need be regulated in the primary station, the only thing regulated being the shunt current of one of the steam engine-driven exciters by means of an automatic Tury type pressure regulator. Although the three-phase current at the busbars is supplied to about 200 asynchronous motors in the factory, 60 of which are for crane operation, the pressure is kept within ± 2 per cent. of the normal within 10 seconds, by means of the automatic regulator placed in the shunt circuit of the exciter. As the motors were nearly all installed about 5 to 10 years ago, their power factor is comparatively small, being on an average about 0.5. The total power factor of the transmission is raised to about 0.8 by means of 3 larger synchronous motors with a total capacity of about 400 k.v.a., which are overexcited, and can furnish a considerable leading current component. It is remarkable that these synchronous motors only get out of step during only about one-third of the lightning storms which strike the line and were referred to above.

The excellent pressure regulation, which has been accomplished here under the most favorable conditions, in an antiquated station with very poor internal pressure regulation, by means of a simpler automatic regulator, which can, without any difficulty, be connected to each exciter and generator, and the operation of which is independent of the speed, phase-shifting and load variations, appears to be far superior to all systems of compounding of alternators, which require complicated exciter connections or commutator devices, and which naturally cannot keep the terminal pressure constant, but can only react on the regulation of certain magnetic fields, when the load variation is comparatively small. The automatic regulator, which consists essentially of a pressure relay, can be over- or under-compounded at will, the relay itself also being provided with a suitable compound winding. Having now described the most interesting features of the installation, a few results of experiences and tests with this high pressure may be of interest.

When the operation with the 30,000-volt pressure was started in the summer of 1900, a large number of the smaller insulators on the line had to be gradually replaced, which, while they were satisfactory during all weather conditions with the former pressure of 15,000 volts, and even during clear weather at 30,000 volts, caused frequent short circuits at 30,000 volts, during rain and wet snowstorms, although only few of the insulators were actually destroyed. At first the operation could only be continued during inclement weather by paralleling the transformers, which were operated at 15,000 volts. The possibility of such an arrangement may be of great value for the uninterrupted operation of high-tension installations. After all the suspicious insulators had been replaced, the new transformers, which were wound for a maximum pressure of 50,000 volts, were placed in service, and it is now no longer necessary nor desired to reduce the pressure to 15,000 volts. Before the 30,000 volts service was started a series of experiments were undertaken, which were to determine the influence of the charging current on the pressure and current conditions of the installation and all extraordinary losses on the line. These effects are most pronounced at no load, when only the magnetizing currents of the transformers and the charging currents of the line are brought into action. It is to be pointed out that comparatively large pressure variations in the generators and transformers, referred to above, without doubt increase the effect of the line capacity and the danger of an increase in the pressure to a certain degree. Three series of tests at no load were made; in the first only two transformers in the primary station were operated by one generator without connecting the line; in the second the line was connected to the transformers, without including the transformers in the secondary station; in the third series the line and the four transformers in the secondary station were connected. Further tests were made at normal loads as well as with the original paralleling of the transformers operating the line at 15,000 volts and under about the same operating conditions and about the same water supply to the turbines with the transformers connected in series and a line pressure of 30,000 volts. In columns 4 and 5 of the table several mean values of the results of these tests are given. These figures are not very accurate, on account of the unavoidable load variations due to the factory motors. But they

FIG. 2.—VARIOUS TYPES OF INSULATORS.

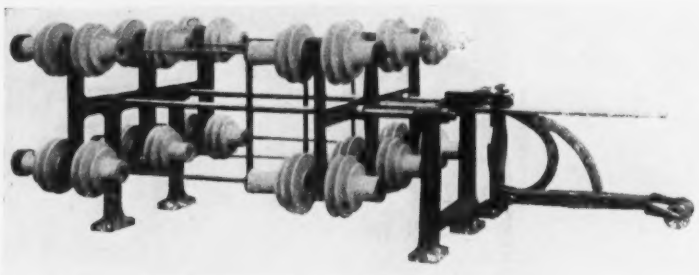


FIG. 3.—HIGH-TENSION SWITCH.

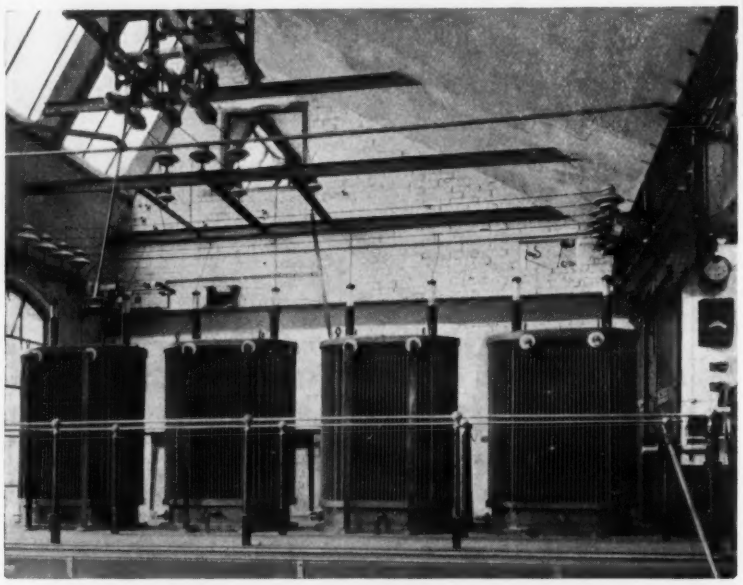


FIG. 4.—OIL-INSULATED WATER-COOLED TRANSFORMERS.

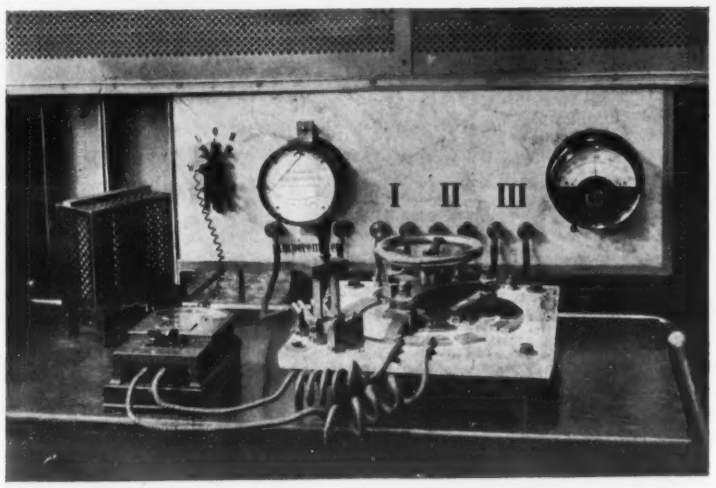


FIG. 7.—SPECIAL SWITCHBOARD AND TESTING SET.

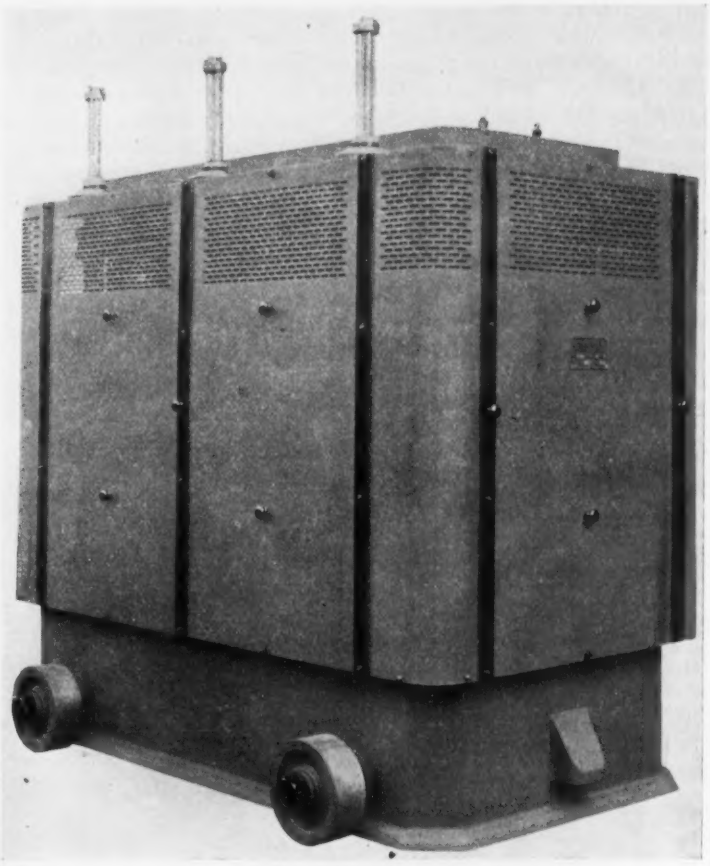


FIG. 5.—VIEW OF A THREE-PHASE TRANSFORMER.

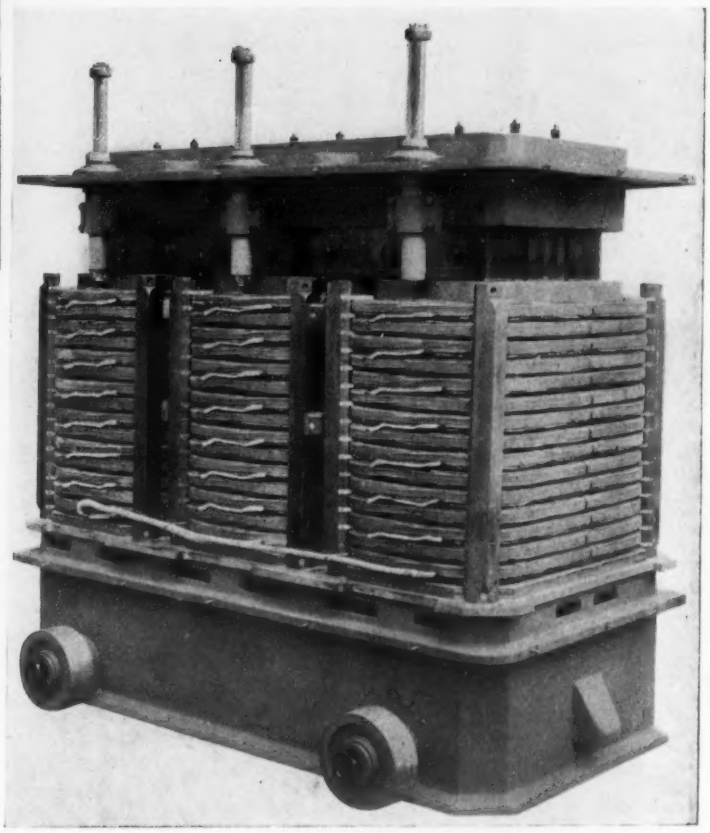


FIG. 6.—COILS OF THREE-PHASE TRANSFORMER.

FIRST EUROPEAN 30,000-VOLT TRANSMISSION PLANT.

show, nevertheless, that at full load the effect of the line capacity is no longer distinctly discernible, and that the only effect which can be noticed is the decreased conductivity loss at 30,000 volts, as compared with 15,000 volts. These experiments will shortly be repeated with an artificial, non-variable load.

In conclusion, the final results of this series of tests are given. The letters refer to the following: Generator speed N, exciter current in amperes i, combined pressure in volts E_1, current in amperes J_1, kilowatts W_1, $cos\ \phi_1$; current strength at beginning of line J_2 and at end of line J'_2; also the tertiary low-pressure E_3, and the tertiary current J_3, the watt delivery W_3, $cos\ \phi_3$ of the transformers in the secondary station.

Test	N	i	E_1	$\mathcal{J}_1$	W_1	$cos\ \phi_1$	$\mathcal{J}_2$	$\mathcal{J}_2$	E_3,	$\mathcal{J}_3$	W_3	$cos\ \phi_3$
1	190	1	31	25	0.36	0.27	...	..	...	....	...	...
	190	1.9	48.5	40	1.8	0.53	...	..	...	....	...	...
	190	2.8	66	48	3.6	0.66	...	..	...	....	...	...
	191	5	83	53	5.4	0.71	...	..	...	....	...	...
	190	7	99	68	7.0	0.61	...	..	...	....	...	...
	190	10	116	80	9.2	0.57	...	..	...	....	...	...
2	190	0.2	22.4	115	0.54	0.13	0.25	..	...	....	...	...
	190	0.2	32.6	140	0.9	0.11	0.4	..	...	....	...	...
	190	0.3	47.8	200	2.2	0.13	0.6	..	...	....	...	...
	190	0.5	66	265	4.3	0.14	0.8	..	...	....	...	...
	190	1	83	331	7.5	0.16	0.9	..	...	....	...	...
	190	1.2	99	382	11.7	0.18	1.25	..	...	....	...	...
	190	2.2	116	449	16.4	0.18	1.45	..	...	....	...	...
3	190	0.9	34.5	110	5.4	0.82	0.2	..	122	....	...	...
	190	1.5	69.0	210	15.3	0.60	0.6	..	226	....	...	...
	190	3.0	104.5	312	32.6	0.57	0.85	..	339	....	...	...
4	190	23.7	100	3200	...	...	18.5	20	233	1010	315	0.77
5	190	23.6	100	3220	...	...	9.6	10	242	1100	375	0.81

1. Series 1 and 2 reveal the important fact by observing the difference in watt losses; that the loss on the line rapidly increases as the pressure is increased, being 1 kw at 20,000 volts, 4 kw at

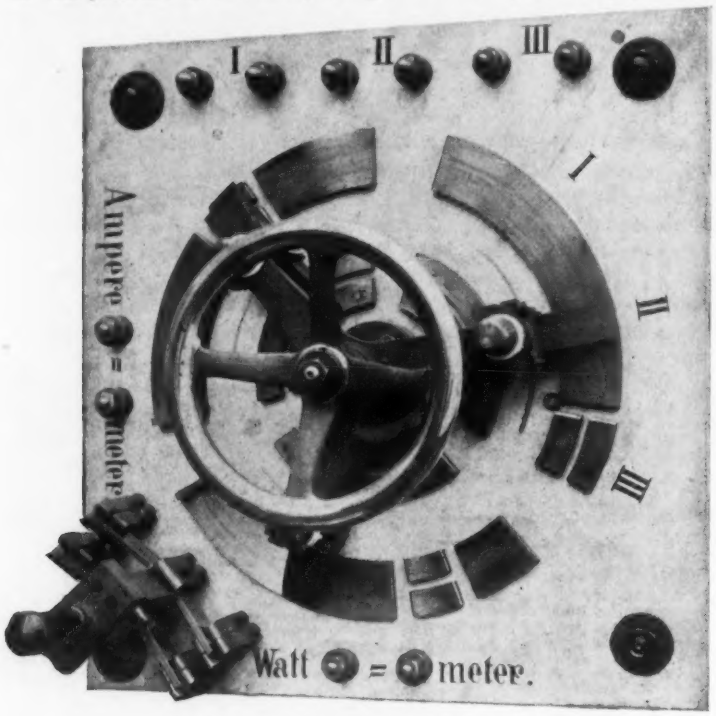


FIG. 8.—FRONT OF SPECIAL SWITCHBOARD.

30,000 volts, 10 kw at 40,000 volts. How much this loss may be reduced by increasing the size of the insulators, has not yet been determined by experiments.

2. The charging current of the line, shown in column 2, agrees with the calculated current, when the capacity C of one phase of the line condenser is calculated by the well-known formula,

$$C = \frac{l \cdot 10^{-5}}{18\ log.\ nat.\ \frac{d}{r}} = Microfaraa,$$

in which d is the distance between wires, l the length of the wires in cm, and r the radius of the wire in cm. Making $l = 22.10^5$, $d = 50$, $r = 0.2$, then

$$C = \frac{22}{18\ log.\ nat.\ 250} = 0.22\ Microfarad.$$

From this the current, J_2, at the pressure E_2 and 50 periods is:

$$\mathcal{J}_2 = \frac{E_2}{\sqrt{3}} \cdot 2\pi \cdot 50 \cdot 0.22 \cdot 10^{-15} \cdot 10^9 = 40 \cdot E_2 \cdot 10^{-6}.$$

The line pressure, E_2, must be calculated from the primary low-pressure, E_1, of the transformers according to the transformation ratio of the transformers connected in series, which is 1: (2 × 154). In consequence of the negative phase difference between the charging current strength and the pressure, there is an increase of pressure in the transformers. This increase was determined by a separate series of tests with the aid of a test transformer. In the third series of the tests, in which the line pressure may be determined from the tertiary pressure, E_3, in the secondary station, according to the transformer ratio at that place, 1: (2 × 53.6), there is a pressure increase in the primary transformers due to the charging current alone, up to 12 per cent. of the primary pressure. In series 2, therefore, the line pressure, $E_2 = 1.1\ .308\ E_1$. For $E_1 = 100$, $E_2 = 34{,}000$. J_2 was observed as 1.25 amperes, and was calculated by the above formula to be $J_2 = 1.36$ amperes. Series 1, 2 and 3 clearly show the effect of the negative phase difference between charging current and pressure on the magnetic field of the generator, as for the same generator pressure in series 2 and 3 a much smaller exciter current was required. The generator pressure in series 2 was for the same excitation as that in series 1, from 1.5 to 2 times as great. The extent of this value naturally depends primarily upon the pressure variations of the generators when loaded and upon the relation between the charging current to the normal load current of the generators, which was very unfavorable in these no-load tests in which only one generator was used for charging. Series 3 clearly shows the magnetizing current of the transformers has the opposite direction from that of the charging current of the line, because in spite of the addition of the four transformers in the secondary station the total generator current, J_1, is smaller than in series 2, in which the line pressure was considered without the secondary station. This effect is also evidenced by the large difference between $cos\ \phi$ in the series 2 and 3. As the charging current at normal pressure is small in comparison with the normal line current at full load, it is to be expected that its effect cannot be observed at normal load conditions. Also the conductivity losses at the high pressure of 30,000 volts, which are shown in series 2 and 3, cannot be eliminated with certainty at normal loads. The ohmic resistance of the line is 31 ohms for one phase, the conductivity loss at 500 k.v.a. and 15,000 volts, is 37 kw and 9.3 kw, at 30,000 volts, so that, after deducting 3.5 kw, which are the losses due to discharges, etc., there is a gain of 24 kw in favor of 30,000 volts over 15,000 volts. The large difference of 375-315 kw in W_3 in series 4 and 5 was probably due to the fact that the service conditions were not exactly alike. The instruments used to determine currents J_1, J_2 and i are not very accurate, and the results are, therefore, not strictly correct. The main pressure was not increased from 15,000 to 30,000 for purely economic reasons, and it matters little to the Oerlikon Company how many kw more are now transmitted from Hochfelden to Oerliken than formerly, but the object was to gain experiences and data with transmissions at very high pressures, in order to be able to undertake to install and guarantee with a commercial certainty installations operating at 30,000 volts.

The above-described investigations served to give a general survey of actual working conditions of this installation, but very soon effects were noticed which required an extension of the experiments. In testing a number of three-phase motors, which were connected to the line in the test room of the factory, it was noticed that there appeared very undesirable unsymmetry in the three phases. There is perhaps no more sensitive device for the detection of the smallest amount of deviation from symmetry in a multiphase system than an absolutely symmetrically wound induction motor operating without a load, and in which the watt and current consumption are measured in every phase. At the slightest disturbance of the symmetry, which no commercial instrument can detect, there is a decided difference in the watt consumption in the various phases of an empty running motor, which frequently even varies the sign, while, for example, the magnetizing current of the motor at rest with open rotor circuits is practically absolutely symmetrical. After all generators and transformers of the installation were found to be practically symmetrical alone and together at all pressures, because a connected empty running induction motor took the same energy and current in all three phases, it was shown that when the line was connected the energy consumed by the three phases of the motor began to vary, and

the variation was greater at 30,000 volts than at 15,000 volts, and greater at no load on the installation than with a load. The unsymmetry of the line appears, furthermore, greater, the greater the drop of pressure of the generators and transformers to which the line is connected. It was greatest, for example, when the 30,000-volt line was connected to a generator and two transformers in the Hochfelden primary station connected in series, when the distributing circuits and the steam-driven dynamo in the Oerlikon secondary station were disconnected. An empty-running, 190-volt, three-phase motor, of a normal capacity of 12 hp, connected to the transformers, showed, during clear weather and at a combined pressure of 230 volts, the following results:

	Current.	Watts.
Phase I	10.7	—18
Phase II	6.5	+303
Phase III	11.6	+627
Total		912

Smaller motors showed similar results and preferably a small ½-hp controller motor was used. In testing the three-line wires, the charging current and watts were about the same in all three phases. The disturbance of the symmetry of the installation to which an empty-running motor was connected must, therefore, have been due to the unsymmetry of the line, which could not be detected with ordinary measuring instruments.

As the three wires form the corners of a right-angle triangle, two wires being suspended horizontally next to each other, and the third one vertically below one of the upper wires, this disturbance of the symmetry could only be due to this unsymmetrical arrangement. It was finally shown that by exchanging the connections of two-line wires to the generator terminals, to which the motor was connected, the watts were changed in the phase in which the line wire was not changed, so that the difference in the motor phases could be varied at will by making various line-phase variations. The next step was to so suspend the three wires, that the line was divided into three sections of about the same length, and the three wires of any one section were connected to the wires in the adjoining one in cyclic order. The division into sections could not be carried out very perfectly for commercial reasons. After this change had been made, the same motor was tested under similar conditions, there being a rainfall in this case, and at a combined pressure of 230 volts, the following results were obtained:

	Current.	Watts.
Phase I	10.2	+417
Phase II	9.0	+138
Phase III	8.1	+360
Total		915

Comparing this table with the previous one, it is seen that there is a decided improvement in the symmetry. It should be stated again that the symmetry of the three phases, by connecting the same motor to the several generators and transformers without connecting the line, and also the symmetry of the motor at rest with open rotor circuit with the line connected, was absolutely accurate, as far as measuring instruments could determine it, and as the following tests will show, the insulation and capacity of the three-line wires measured by themselves showed no appreciable deviations. In the main pressure also no variations of the three phases could be detected with certainty.

FIG. 9.—EXTERNAL REVOLVING-FIELD GENERATOR, ROPE-DRIVEN.

From this the lesson may firstly be drawn that in testing three-phase motors the symmetry of the entire system should be carefully investigated, although the ordinary instruments may not indicate any disturbance. Tests to determine the extent of the various phase differences and the relation between these probably very small deviations and the behavior of the motor, have not been concluded.

Already during the preliminary tests there were noticed at times large variations in the data regarding the energy loss on the line, which led to a repetition of the experiments, until the relation of this energy loss to the weather conditions could be definitely determined. Finally a regular testing table was set up in the Oerlikon station, in order to test the line losses during the noon hour, when the power load was taken off. The steam-driven dynamo at Oerlikon, with the transformers in the secondary station, served as a source of current, the transformers at the Hochfelden primary station were taken out of the circuit, and then the energy consumption of the

secondary transformers without the line was measured at different pressures, and then the same measurements were made with wattmeter and ammeter, with the line connected. The difference gives the various losses on the line, after the small ohmic losses have been deducted. As the line loss is generally but a small proportion of the transformer losses, the measurements must be made with great care, and above all the generator must be evenly regulated. The series coil of the wattmeter and the ammeter may be inserted into each phase without breaking the circuit by means of a special switchboard, and the shunt coil can be inserted either between the neutral point of the generator and the various circuit phases or watt measurements by the two-wattmeter method, between two circuits. By means of a special switch the wattmeter reading may be reversed. This board is shown in Figs. 7 and 8. The watt measurement with or without line for each point may be made by the two-wattmeter method and subsequently in each separate phase. In the following table the results of two sets of tests are given with the four old three-phase transformers, the first set having been made on February 4, 1902, during a light snow fall and a temperature of 1.5°, the second set on March 11, with a clear sky and a temperature of 5°, but after a night frost of — 4°. The current was measured in the same circuit, in which the series coil of the wattmeter was located. The number of periods in each test was 50.

TEST ON FEBRUARY 4, 1902.

(Slight Snow Fall. Temp. +1.5°.)

Pressure 1000 volts ×				Current Amp.			Watt meter read'g			K.W. Total	Remarks
16.3	16.8	16.8	23	25	25		7.7	10.1	10.2	6	Dithout line.
20.3	20.3	20.3	30	30	30		14.1	15	14.9	8.8	
24.1	24.1	24.1	38	39	38		18.9	20	19.8	11.7	Four old transformers.
26.6	26.6	26.6	41	43	43		22.3	24.9	24.9	14.4	
28.6	28.6	28.6	43	47	47		26.2	28.7	28.8	16.7	
30.1	30.1	30.1	47	49.5	49.5		29.1	31.2	31	18.2	Wattmeter constant: 200.
32.4	32.4	32.4	49.5	51	50.5		32.7	35.1	34.7	20.4	
33.5	33.5	33.5	50	52.5	52.5		34.5	37.1	36.8	21.6	
17.0	17	17	60	60	60		5.6	5.9	5.9	6.6	
19.6	19.6	19.6	75	76	77		7.3	8.1	8.6	9.6	With line.
23.8	23.8	23.8	103	104	104		11.2	12	12.1	14.2	
27.3	27.3	27.3	129	130	130		15	16.2	16.3	19	
29	29	29	143	144	145		16.8	18.2	18.5	21.4	Wattmeter constant: 400.
31	31	31	163	157	157		20	20.2	20.1	24.2	
32.5	32.5	32.5	182	180	182		22.1	23.7	24	28	
33.8	33.8	33.8	194	195	196		23.8	25.7	25.9	30.4	

TEST ON MARCH 11, 1902.

(Cloudless Sky. Temp. + 5°. Preceded by Night Frost of —4°.)

Pressure 1000 Volt ×			Current Amp.			Wattmeter Read'g			K.W. Total	Remarks
I.	II.	III.	I.	II.	III.	I.	II.	III.		
12	12	12	18	18	18	4.9	5.6	5.4	3	Without line.
14.7	14.7	14.6	20	20	20	7.7	8	8	4.7	
17.3	17.3	17.2	23	23	24	10.8	11.4	11.3	6.6	
20.1	20.1	20.2	25	25	25	13	14.8	14.9	8.5	Four old transformers.
23.3	23.3	23.3	28	30	30	17.9	19.4	19.7	11.4	
25.3	25.2	25.3	30	32	32	19.9	21.8	21.5	12.6	
27	27	27	35	37	36	23.9	26	25.8	15.1	
28.6	28.6	28.6	40	42	42	26.2	28.3	28.2	16.5	
30.1	30.1	30.1	43	45	45	28.8	31	30.8	18.1	
32.2	32.2	32.3	47	49	49	31.8	34.5	34.5	20.2	
34.9	34.9	34.9	49	50	50	34.5	37.3	37.1	21.8	
13.4	13.4	13.3	30	38	38	7	7.8	7.3	4.4	With line.
14.7	14.7	14.7	43	45	44	8.4	9	9	5	
17.3	17.4	17.5	56	..	..	11.1	12.3	12.2	7.1	
20.8	20.8	20.9	72	75	76	15.4	16.9	17.8	10.1	
23.3	23.3	23.3	91	91	91	19	20.3	21.1	12	Wattmeter constant: 200.
25.3	25.3	25.3	107	108	108	22.5	24.9	25.9	14.6	
27	27	27	116	116	115	24.6	26.7	27.5	15.8	
29.5	29.5	29.5	144	145	145	30.7	33.3	34.2	19.6	
30.5	30.5	30.5	153	154	154	15.9	17.1	17.7	20.3	Wattmeter constant: 400.
32.3	32.3	32.4	147	176	176	17.9	19.4	20	22.7	
34	34	34	200	204	206	19.8	21.5	22.1	25.6	

Similar experiments were made under various weather conditions. The current and energy are graphically plotted as a function of the high tension with and without line and the difference between the two ordinate values is obtained for each pressure value. From this difference the small copper losses in the transformer and line are subtracted.

The following table is compiled from the various tests made:

TABLE OF WATT LOSSES.

Weather	Air Temp. °C.	Loss in kilowatts 20,000 volts	25,000 volts	30,000 volts	34,000 volts
Cloudless sky; quite dry	+25°	0.6	0.75	0.9	1.0
Cloudless sky; frost during previous night	+5°	0.68	1.05	1.8	3.1
Snow fall with small flakes; temp. below 0°.	—4°	2	1.4	2.2	3.5
Clear air, cloudy; several hours previous light rain	+7°	1.3	2.0	3.0	4.2
Snow fall with light flakes; temp. above 0°	+1.5°	1.5	2.7	4.9	8.7

The remarkable feature of these tests is the connection between the charging current and the line watts. The current increases more quickly than the pressure, so that the quotient obtained by dividing current by pressure, which was employed above in the calculation of the line capacity, is not constant, but increases rapidly with the pressure. That the measured current strength in the low-pressure winding of the transformers is nearly proportional to the high-tension current in the line, except for the small influence of the magnetizing current, was determined by separate measurements of the line current. It should be stated that the current measurements were not very accurately made, because the ammeter scale was not sufficiently accurate for all values of the current. In all tests, however, the same errors are present. If, for example, the apparent capacity is figured in the above tests with the power factor ($cos\ \phi$) from the quotient obtained by dividing current by pressure, we obtain the following table:

TEST I.—WITH LINE.

Pressure 1000 ×	17	19.6	23.8	27.3	29	31	32.5	33.8
Cos.	0.4	0.39	0.355	0.33	0.32	0.30	0.29	0.28
Cap. M. F.	0.21	0.23	0.24	0.28	0.29	0.31	0.33	0.34

TEST II.—WITH LINE.

Pres. 1000 ×	13.4	14.7	17.3	20.8	23.3	25.3	27	29.5	30.5	32.3	34
Cos.	0.55	0.47	0.43	0.40	0.35	0.33	0.31	0.28	0.27	0.25	0.23
Cap. M. F. .	0.16	0.16	0.19	0.21	0.23	0.25	0.25	0.28	0.29	0.32	0.35

These tests, using the new transformers, gave considerably different results.

Comparing these tests with those shown in the first table in this paper, in which one generator and two transformers of the primary station at Hochfelden were used as a source of current, it will be seen that in series 2 of that table the power factor gradually rises with the increasing pressure, while the apparent capacity remains almost constant. The last tests, in which the Oerlikon steam-driven dynamo is used as a source of current, therefore show that with increasing pressure, the current curve of the generator is changed, the peaks being higher with higher pressures. The Hochfelden

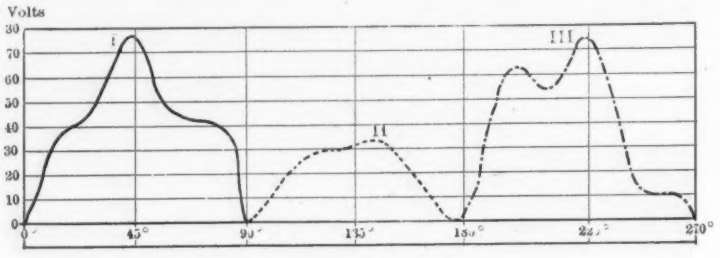


FIG. 10.—CURVES SHOWING RELATIVE VALUES OF THE THREE PHASES.

generator varies from the Oerlikon generator by having its e.m.f. curve follow very closely the ordinary line curve. The Oerliken generator has well-defined peaks of triple the periodicity. These effects are generally known, but for this case, having been observed in actual practice, some originality may be claimed. The curves shown herewith show the variations of the terminal pressure of the generator, (1) with line at 34,000 volts, (2) with line at 18,000 volts, (3) without line at 34,000 volts.

It is to be expected that to these data which cover the two-year experimental period, further information will be added as time goes on, and new experiences will be gained by the operation of the 50,000-volt line, which will soon take place. The possession of such a transmission line is of great value to the Oerlikon Company, which must be evident to all who have read the above and other articles on the same installation.

Message Time Limit.

At the Interstate Independent Telephone Association, Mr. H. E. Ralston, of Maitland, Mo., read a paper which strongly argued in favor of enforcing the message time limit in toll-line business, and condemned any system of flat-rate charges. He said that the more he has to do with telephone business, the more he thinks that measured service should be adopted for all cases, even to the smallest exchanges; and that if he could begin over in his territory, he would only place telephones on these terms. Those who would object are of the type who are after something they do not want to pay for, and they should not be encouraged. He suggested that if the majority of messages are of three minutes' duration, the minimum of three minutes should be adopted, or if five minutes is the average, that should be the limit; in either case there would be no real cause for complaint on the part of the public.

Analysis of Wireless Telegraph Systems in 1902.

BY A. FREDERICK COLLINS.

IN former articles in the ELECTRICAL WORLD AND ENGINEER I described a number of foreign and domestic system of wireless telegraphy and have pointed out, in so far as possible, the difference in the theories upon which they are based, as well as those apparent in the electrical and mechanical construction of the apparatus.

In view of the recent litigation in Germany, in which the Braun and Slaby-Arco systems figured so prominently, and that now pending between the Marconi and De Forest companies in the United States, it would seem of interest to compare the various methods and appliances and show wherein a similarity exists between them. In a comparative analysis of this nature, it may be necessary to delve occasionally into the history of the art and to classify the types of instruments employed, as both will have a vital bearing on the ultimate decision which may be handed down by the courts.

The various hypotheses advanced by inventors to account for phenomena or apparatus constructed upon theoretical data which cannot be proven to be based on fundamental and well-established facts, will not play very important parts in the coming wireless suits. And the construction of the instruments will form the principal object or argument in which the question of discovery and invention will be centered on a very limited number of component parts—perhaps only two or three—of those on which rests the problem of transmission without wires.

In classifying the different systems in order to compare them, it is evident that the start must be made with the first operative wireless telegraph, designed by Marconi in 1896. This treatment will embrace the work of Marconi, Lodge, Slaby-Arco, Braun, Fessenden, Guarini, Ducretet and De Forest, and may be divided into two general classes—namely, *A*, syntonized wireless telegraphy, and *B*, non-syntonized wireless telegraphy; and these into two sub-classes: *C*, oscillators and resonators having grounded arms, and *D*, oscillators and resonators which are not grounded. Subdivisions of these classes resolve the transmitting apparatus into (*a*), generators of the induction-coil type; (*b*), generators of the transformer type; (*c*), oscillators connected in series with the antennæ and ground; (*d*), oscillators operating through transformers; (*e*), oscillators of the open-circuit type; (*f*), oscillators of the closed circuit type; (*g*), oscillators of the compound-circuit type; (*h*), transmitters having tuned internal circuits, and (*i*), transmitters which are non-tuned.

The electric wave system, or resonator, is usually similar to that of the oscillator, though the function of the former is diametrically opposite to that of the latter in that electric oscillations set up in an emitter radiate electric waves, and the waves impinging on the electric wave resonator are transformed into electric oscillations. Receivers may be sub-classed as follows: (a^1), receivers with tuned internal circuits; (b^1), receivers with non-tuned circuits; (c^1), open-circuit resonators; (d^1), closed-circuit resonators; (e^1) compound-circuit resonators; (f^1), electric wave detectors connected in series with antennæ and ground; (g^1) electric wave detector operated through transformers; (h^1) receivers employing coherers; (i^1) receivers employing anti-coherers; (j^1), receivers employing magnetic wave detectors; (k^1), receivers operating Morse registers, and (l^1), receivers operating telephones.

The first Marconi apparatus involves the fundamental principles of wireless telegraphy, and belongs to the *B C* classes of non-synchronized instruments having grounded oscillator and resonator arms. It consists essentially of a transmitter having for its generator an induction coil, (*a*); but the specifications in Marconi's patent do not limit its operation to a coil, but state broadly that it may be replaced by any other source of high-tension electricity (*b*). The oscillator is in series with the antennæ and ground (*c*), and is of the open-circuit type, (*e*). It is not tuned to any periodicity of oscillation except that it is in natural tune with any other receiver which may be grounded, as referred to in my recent article[1] in these columns.

The meaning intended to be conveyed by a non-tuned circuit oscillator, or resonator, is that the apparatus is constructed without regard to the period of oscillation set up in the emitter, the length of the waves propagated or the frequency of oscillation created in the resonator by the incoming waves. A tuned internal circuit refers more especially to circuits of more or less complex apparatus of recent origin relating, especially to syntonic devices in which there are two circuits, both of which must be in tune with the other, or in which the oscillations are transferred before emission from the oscillator or after reception by the resonator.

The Marconi receiver forming the opposite part of the above transmitter is necessarily of the *B C* and the b^1 sub-class, having a non-tuned resonator; it operates by means of an open-circuit resonator, c^1, the antennæ and ground of which are in series with the coherer f^1, thus conforming with h^1 k^1. The apparatus is shown in the diagram, Fig. 1, the letters corresponding to those preceding the classes and sub-classes.

The Lodge system of syntonic wireless telegraphy was the first which aimed at selective signaling, and, therefore, represents a new distinctive class, which we shall call *A*, and likewise establishes a precedent in the art by eliminating the earth from the oscillator and resonator, which fulfills the sub-class *D*. The transmitter operates by means of an induction coil, (*a*), the oscillator system is of the open-circuit type, (*e*), and to preserve the uniformity of the oscillator system that the wave emitted may follow a sine-wave law, both arms have the same values of induction and capacity, which is not possible when so great and unequal damping coefficient as the earth is loaded on one arm of the oscillator. The great advantage of this arrangement is to permit true selective tuning between instruments, and the great disadvantage in this case of eliminating the earth as a resonant factor is that the distance over which it is operative is exceedingly limited.

The tuning is accomplished by varying the capacity areas and the inductance coils, shown in Fig. 2. But the greatest point of interest in the Lodge invention lays in the construction of the resonator system of the receiver. It will be observed by referring to the dia-

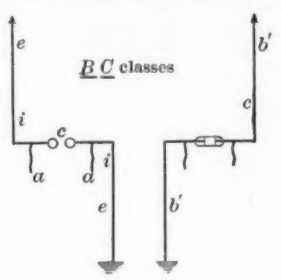


FIG. 1.—FIRST MARCONI WIRELESS TELEGRAPH.

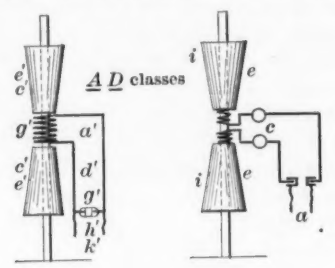


FIG. 2.—LODGE TUNED SYSTEM WITHOUT GROUND.

gram that the resonator is of the compound-circuit type, (e^1), and in the sub-class, (a^1), having a tuned internal circuit—connected with the coherer—and, (g^1), which is operated through a transformer. This device renders the actions of the oscillations set up in the resonator independent of the instability of the coherer through its varying changes of resistance and capacity. This is, in my opinion, one of the greatest improvements in the original resonator, and upon this point legal complications will undoubtedly ensue, since the Slaby-Arco, Marconi, Braun, Guarini and De Forest apparatus employ this transformer device; yet there are in these systems a certain difference which may or may not make them amenable to the claims of Lodge, according to the interpretation of the patent claims of each. The receiver operates a Morse register.

The Slaby-Arco system, shown in Figs. 3 and 4, has two forms of transmitters and a receiver. The transmitter, 3, was designed to send out waves of a prearranged definite length, but both from theoretical and practical considerations it was supplanted by the type 4. It is well known to those versed in the art that electrical resonance is extremely difficult to obtain by means of high-frequency, high-potential currents in the resonator when there are only two or three swings in the radiator system; but as the oscillations become more and more persistent, resonance in the sending and receiving systems is the more and more easily effected. Since persistent oscillations are a characteristic feature of closed-circuit systems, (f d^1), it follows in natural sequence that the 3 type of Slaby-Arco transmitter operates as such by means of the circuit formed through the earth, as by the grounded terminals of the antennæ and vertical wire. Whether or not this thought was uppermost in the minds of the inventors when they designed the transmitter 3, it produces this effect. It is postulated that all oscillations of a frequency capable of emitting waves four times the length of the wire, will propagate them through

[1] "Hertzian Waves and Wireless Telegraphy," September, 1902.

space; but when the periodicity of the oscillations is not in tune with the antennæ through which they travel, they are dissipated in the induction coil or find their way to the earth through the second grounded vertical wire, and in either case no waves are radiated, or if any, they are very feeble. This transmitter does not seem to infringe upon the Lodge form, but it evidently encroaches upon the Marconi type, in that it employs a grounded wire leading from the oscillator and an antennæ connected to the opposite side, (*c*). This forms the first closed circuit oscillator system, but as its function was primarily described to emit waves of a definite length and not to increase the number of oscillations per discharge across the spark-gap, it will probably have little effect on the validity of claims made for apparatus in which this is the express purpose.

The Slaby-Arco transmitter of the Fig. 4 type is the first of the

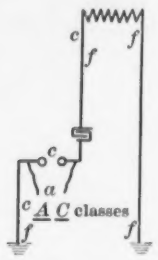


FIG. 3.—SLABY-ARCO CLOSED-CIRCUIT TRANSMITTER.

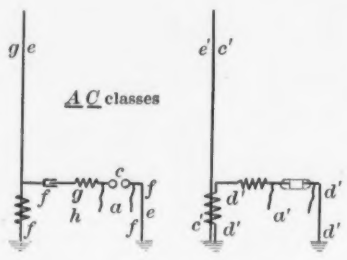


FIG. 4.—SLABY-ARCO MULTIPLE-TUNED CIRCUIT SYSTEM.

compound-circuit oscillators, class *A*, sub-class *C*, and sub-division *g* and having a tuned internal circuit, *h*. The arrangement produces complex phenomena, the theory of which is easy to attack but difficult to disprove. There are some clever devices for obtaining harmonic effects between the wave-emitting antennæ and the high-frequency current set up in the oscillator system. The inductance, 1, consists of a few turns of heavy copper wire, wound around a heavy pasteboard box containing a number of Leyden jars,[2] by which the periodicity of the oscillations may be varied within certain values, as well as by increasing or by decreasing the resistance by means of the spark-gap, 3. If it is proposed to include the oscillator defined by 1, 2, 3, 4, 5, 6 and 7, a closed oscillator system results, and persistent oscillations will be produced. If the antennæ includes the open circuit formed by 5, 6, 7, 8, then the oscillator and emitter will each have the good qualities of the open and closed circuit, *i. e.*, the persistency of oscillation of the closed circuit and the wave-emitting qualities of a damped open-circuit oscillator. The inductance coil, 6, serves to obtain and maintain a greater accuracy of adjustment of the coefficients of inductance and capacity between the antennæ and the tuned internal circuit, *h*, making the frequency of oscillation correspond in both circuits. The transmitter includes an ordinary induction coil, a key with a magnetic spark blow-out and mercury turbine interrupter.

The Slaby-Arco receiver is, Fig. 4, constructed upon similar lines to the transmitter, being a compound-circuit resonator, (c^1), of the *A C* type, having the internal closed circuit in tune with the external open circuit, and these syntonized with the transmitters, in so far as additional inductances and capacities can be made to a grounded resonator with a grounded transmitter, the object, of course, being to produce a selective syntonic system. A coherer, (h^1), is connected in series with the antennæ and ground, although, according to the Slaby theory, it does not follow the sub-class, f^1, since he postulates the two circuits are separate and distinct. A Morse register operating through a polarized relay and actuating the decohering device makes it amenable to the k^1 class.

The element of similarity between the Slaby-Arco and the previously described system of Marconi is that of employing a vertical wire in both the transmitting and receiving instruments, and providing grounds oppositely disposed to the antennæ with the spark-gap and coherer intervening—although this statement is open to criticism insomuch as in the case of the receiver the antennæ and closed circuits are grounded at the same point.

The Slaby-Arco resembles the Lodge system in the use of inductances in tuning the individual instruments and syntonizing the two station sets collectively. A further resemblance to the Marconi and Lodge instruments is in the fundamental principle utilized in producing the oscillations by a Ruhmkorff coil, (*a*), and a spark-gap, and receiving the waves by means of a coherer, (*h*), and by translating the impulses into Morse dots and dashes by a register, (k^1), acting through the desired circuit of a relay.

The syntonic wireless transmitter of Marconi is in a few features like that of the Slaby-Arco. One is evidenced in connecting one side of the oscillation to the antennæ, which is grounded precisely as it is in the Slaby-Arco, but the Marconi is not a compound oscillator, neither may it be said to be an open or closed oscillator, but rather a cross between them. The system is of the *A C* class, and consists of two concentric cylinders, Fig. 5, of large dimensions, which serve as the antennæ. This is intended to and would give persistent oscillations, were it not for the inner one being weighted with the capacity of the earth, when it would resemble a magnified edition of the Lodge syntonic jar emitter which has a closed circuit. But Marconi evidently does not consider it as such, since he was the first to point out the defect of Slaby's first transmitter which formed a closed circuit. Assuming that it has wave-emitting properties greater than a closed-circuit oscillator, it must follow that the air core separating the two cylinders is considerably greater in proportion to its size than the proportional thickness of the dielectric separating the coatings of the Leyden jar, or that the earth has a tendency to damp out the oscillations to a certain extent, or both; but taking this for granted and crediting the logical deduction that such an apparatus will give persistent oscillations, it follows as a natural sequence that it is a combination of devices for producing a compound effect of *e. f. g.*

The syntonic wireless receiver of Marconi is constructed upon the same plan, the inner cylinder forming the antennæ with direct grounding. It is like the Lodge receiver in that the oscillations set up in the resonator by the incoming electric waves are transformed by a small coil having a primary and secondary winding; and it is like the Lodge and Slaby-Arco receiver in using inductance coils as a means of obtaining a given periodicity of oscillation. It belongs to the *A C* class and the a^1 c^1 d^1 c^1 (anomalous-circuit resonator), g^1 h^1 and K^1 sub-classes.

Dr. Slaby has devised a portable system of wireless telegraphy in which the question of syntonization does not enter seriously, the transmitter following the *B C* classes. The transmitter is identical with the first Marconi form, the antennæ being suspended from kites. The resonator is based on the principle of that described in the Slaby syntonized system, with the antennæ grounded direct and one terminal of the coherer likewise grounded, joining an open and closed circuit of the compound type; but instead of an ordinary coherer, a self-righting one is substituted, and a telephone receiver takes the place of the Morse register, tapping device, complex circuits and relay. This receiver is arranged in accordance with Dr. Slaby's theory for obtaining an approximate resonance with a non-syntonized

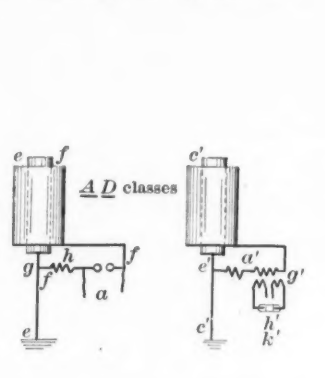


FIG. 5.—MARCONI SYNTONIC SYSTEM. FIG. 6.—BRAUN COMPOUND CIRCUIT SYSTEM.

transmitter, and may be designated by the class letters, *A, C,* a^1, c^1, h^1 and f^1. What was said of the previously-described Slaby-Arco receiver is likewise applicable to this form.

The Braun syntonic system (Fig. 6) appears to be based upon principles which are absolutely sound, theories which have been proven by experiment and practice, and compound circuits which are clearly defined. The Braun transmitter, like the Lodge, is modeled after the original Hertz emitter, in that it is not grounded, and, being eminently adapted to selective wireless telegraphy, it is in the *A, D* classes. It consists of two circuits, sharply cut, one a closed oscillator in which high-frequency and high-potential currents are set up, and these are

[2] Slaby-Arco Wireless Telegraph Apparatus, ELECTRICAL WORLD AND ENGINEER, May 1, 1902.

stepped-up or stepped-down by a transformer, the primary of which is included in the closed circuit, and acts as a variable inductance for tuning the said circuit so that it will have the same frequency of oscillation as the natural period of the open circuit which receives its oscillations through the secondary of the transformer, and connecting in series with two wires, both having a length equal to one-fourth of the length of the wave to be emitted. One of these wires serves as the antennæ, and the opposite is coiled loosely or connected to a plate of metal having the proper amount of capacity.

As in the systems described, the Braun receiver is a duplicate, as nearly as may be, of the transmitter. It has a tuned internal circuit resonator, (a^1), one arm including the coherer, (h^1), a compound-circuit resonator, (e^1), the closed circuit connected in series with the antennæ, (a^1), and an opposite wire of equal length, but not grounded, (D), connected thereto, and this operating the open-circuit resonator, (c^1), through a transformer. The receiver proper is a Morse register tapper, relay and other accessories, (k^1).

The tuning, internal (a^1) and selective (A), is done by means of condensers, usually Leyden jars, and the inductance coils shown in

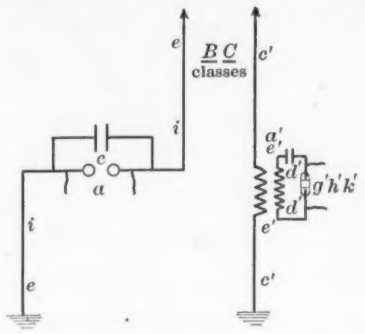


FIG. 7.—GUARINI REPEATER SYSTEM.

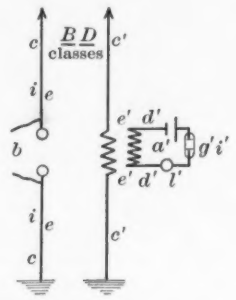


FIG. 8.—DE FOREST WIRELESS TELEPHONE SYSTEM.

Fig. 6. The points of similarity between the Braun and the first Marconi system lay in the use of a vertical sending and receiving wire, a spark-gap and a coherer; it resembles the Lodge in employing a transformer in the receiving apparatus which is virtually the equivalent of a compound circuit resonator, and the use of condensers and inductances to regulate the tuning coefficients. It is like the Slaby-Arco system only in the use of antennæ, which equals one-fourth of the emitted and received wave value.

The recent patents granted to Fessenden show some important advances in the art of tuning were they not handicapped by the earth terminals of the oscillator and resonator. In this system the transmitter derives its energy from the generator, (a), the oscillator of which is connected in series with the antennæ and ground, (c), but has a tuning grid composed of straight wires immersed in oil and having a combined inductance and capacity, also in series with the antennæ, oscillator and ground, the whole forming an open-circuit oscillator of (e). The receiver is in series with the antennæ and earth, (f^1), and consists of a magnetic wave detector, (j^1), of novel construction, and a head telephone receiver, (l^1). It is an open-circuit resonator, and with its oscillator is like the Marconi system, in that it requires a vertical sending and receiving wire connected in series with an oscillator and resonator, as the case may be, which then leads to earth. It follows the law governing the Lodge, Slaby-Arco, Marconi and Braun system in striving for resonance by means of inductance and capacity, but unlike theirs, Fessenden's variations of these coefficients is not done through inductance coils and condensers, but by means of straight wires immersed in a medium having a large specific inductive capacity. The magnetic wave detector takes it out of the sub-class of coherers and places it in a new class by itself.

Guarini's wireless telegraph repeater is not related in any way to syntonic systems, but its features of similarity to those preceding it, will be described. Its generator is an induction coil, with the opposite terminals of the spark-gap in series with the antennæ and earth, forming an open-circuit oscillator of the B C type, like the first Marconi apparatus. There are no tuned circuits, but the coherer is actuated by the oscillations set up in the resonator through a transformer, thus producing a compound-circuit resonator, in accordance with the specifications of Lodge, Marconi and Braun. See Fig. 7.

Like the above, the De Forest system mades no claim to syntonic methods, but introduces several novel features. It is the only system using a generator of the transformer type, (b); current from an engine-driven alternator having a potential of 500 volts is stepped-up by a commercial transformer to a voltage of 20,000, or higher. The oscillator is connected in series with the antennæ and earth, and is of the open-circuit type. The resonator is also of the B C type, and operates an anti-coherer, (i^1), through a transformer, as in the Marconi, Braun and Guarini receivers; the impulses are translated into Morse by head telephones, through the responder like that of the Slaby-Arco portable system. (Fig. 8.)

The equipment of Ducretet follows closely the first Marconi apparatus, though sometimes substituting the telephone receiver and a self-restoring coherer for the ordinary coherer and Morse register, as in the Slaby-Arco portable sets and the De Forest systems.

These are the principal systems in use to-day, and show wherein there is a marked likeness of operative devices. In the Braun-Slaby-Arco suit, the alleged infringement of rights involved the similarity of theory and priority of invention of the compound oscillator circuits, with a special reference to that portion treating of the antennæ. However, the Braun patents were sustained by the court's decision, which ruled that the systems were different so far as the contested principles were concerned.

In the Marconi-De Forest suit, brought by the former company against the latter, the question of infringement is based upon claims which refer to the use of an imperfect electrical contact for detecting the waves. In the Marconi system, the well-known coherer is employed, whilst in the De Forest system a device, termed a responder, which increases the resistance of the local circuit, is used.

The final decision of the courts will be awaited with interest, as the case will determine largely whether or not Marconi is to have a monopoly of electric wave wireless telegraphy in the United States, and whether or not his patents are as broad and far-reaching as the waves his instruments send forth.

The Relation of Synchronous Impedance to the Impedance at Standstill.

BY F. TOWNSEND, H. P. FREUND, W. I. REICH.

THE method in general use in this country for predetermining the regulation of an alternator is to find the synchronous impedance of the machine from the open-circuit saturation curve in connection with the short-circuit characteristic, which is the relation between the field amperes and the corresponding values of armature current at short circuit. The synchronous impedance is given by the ratio, open-circuit volts divided by short-circuit armature current for any given excitation, and it is found that this fraction is very nearly constant for all excitations which correspond to the straight part of the magnetization curve. In Fig. 1 the rela-

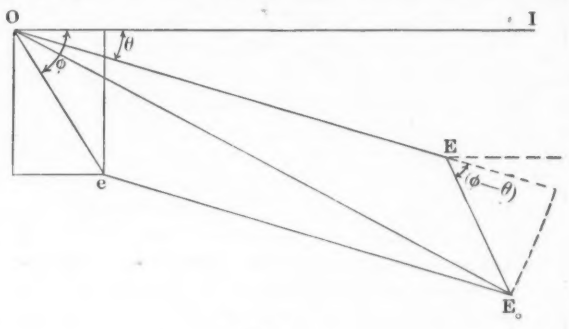


FIG. 1.

tion between the induced volts OE_0, the synchronous impedance drop OE and the terminal voltage OE are shown diagrammatically, the main discrepancy between the relations shown and those in an actual machine being that the resistance drop is generally relatively unimportant, so that the angle ϕ is very nearly 90°, and $cos\ (\phi - \Theta)$ is practically the same as $sin\ \Theta$. It is plain from the diagram that the difference in length between OE and OE_0, or the armature drop, is therefore very nearly given by the equation

$$\Delta E = oe\ cos\ (\phi - \Theta) = Z\ I\ sin\ \Theta$$

Now the constant Z is determined at short circuit and takes into account not only the demagnetizing effect of the armature current, which, below saturation, is very nearly proportional to $I\ sin\ \Theta$, but also the counter e.m.f. due to the leakage flux, which is not cut by the conductors on account of their mechanical motion, but on account of

the variation of the current, and therefore produces a counter e.m.f. which is always regarded as the true inductance drop.

Since the diminution of voltage due to this inductance is also nearly proportional to $I \sin \theta$, it is evident that no appreciable error is involved in combining the two factors of proportionality into a single constant called the synchronous impedance.

The object of the experiments about to be described was to compare the values of impedance obtained at standstill with those of synchronous impedance determined in the usual way.

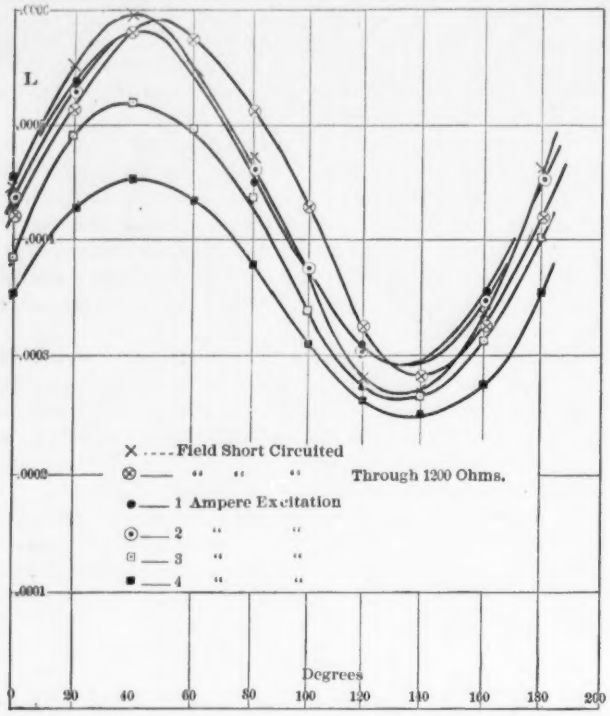


FIG. 2.—INDUCTANCES AT STANDSTILL—MACHINE (*a*).

The machines tested were as follows:

(*a*) 10-hp, double-current generator.
2-phase—60 cycles—77 to 110 volts—1,800 r.p.m.

(*b*) 60-kw alternator—smooth core.
Single-phase—125 cycles—1,000 volts—1,070 r.p.m.

(*c*) 5,000-kw alternator.
3-phase—25 cycles—11,000 volts—75 r.p.m.

All the values of inductance determined with the machine at standstill were obtained by passing current through one phase of the armature, and noting volts, amperes, watts and frequency; the value of L was then calculated from those readings by the equation,

$$L = \frac{\sqrt{E^2 I^2 - W^2}}{I^2 \omega}$$

It was found, however, that the wattmeter reading was so small that W^2 could be neglected in comparison with $E^2 I^2$.

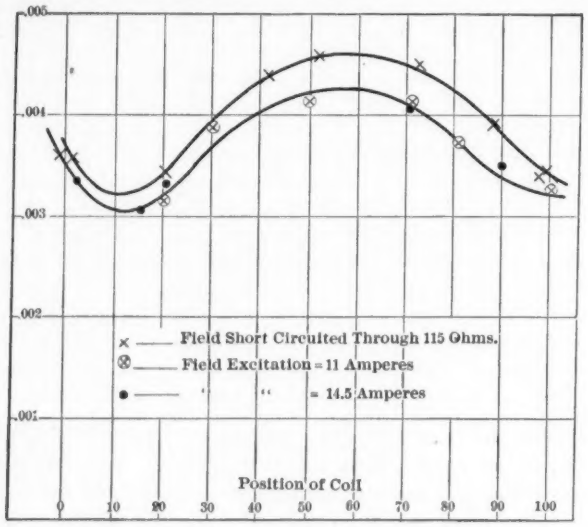

.005
.004
.003
.002
.001
× —— Field Short Circuited Through 115 Ohms.
⊗ —— Field Excitation = 11 Amperes
● —— " " = 14.5 Amperes
Position of Coil
0 10 20 30 40 50 60 70 80 90 100

FIG. 3.—INDUCTANCES AT STANDSTILL—MACHINE (*b*).

Figs. 2 and 3 show the effect of the field excitation on the value of L, and it appears from them that the average value is diminished some ten or fifteen per cent. by the saturation of the iron.

In order to show that this diminution was due to saturation and not to a transformer action on the part of the field circuit, the series of tests shown in Figs. 2 and 4 were made with the field winding short-circuited on itself. These results indicate that in the particular machines tested there was little or no transformer action between the armature and field circuits.

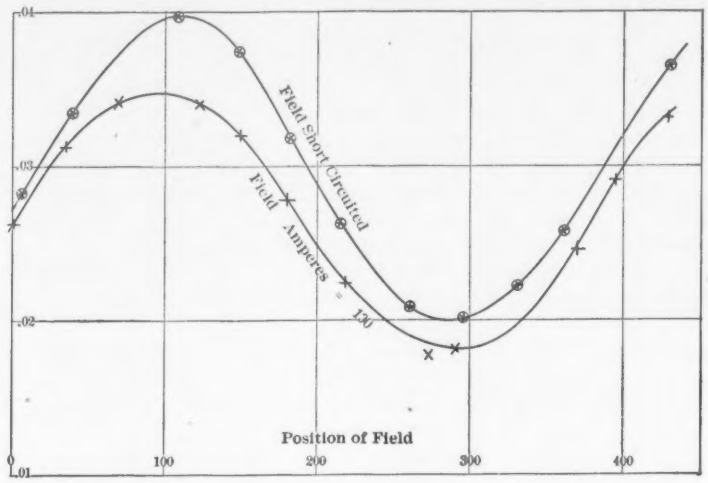


FIG. 4.—INDUCTANCES AT STANDSTILL—MACHINE (*c*).

The effect of a variation in frequency on the value of L was found to be very slight. This is brought out in Fig. 5, where the observations show a very small diminution in L produced by a change in frequency of 50 per cent. L varies inversely with the frequency, because the eddy currents act in the same manner as the secondary current of a transformer, and diminish the apparent inductance of the primary as the frequency rises; the "primary" in this case is the armature circuit of the machine tested.

Between zero and full load it was observed that the values of L appeared to be independent of the armature current at which they were determined; this is owing to the fact that, in the machines tested, the armataure current was not sufficient thoroughly to saturate the leakage paths.

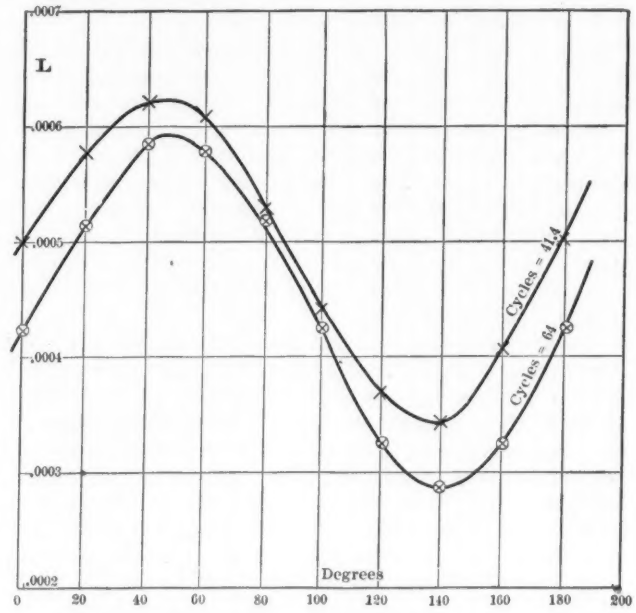


FIG. 5.—EFFECT OF FREQUENCY ON INDUCTANCE AT STANDSTILL—MACHINE (*a*).

Fig. 7 shows two external characteristics for the 5,000-kw alternator. Each curve is calculated for a power factor equal to .4, but as indicated in the diagram one is derived from the measurement of impedance obtained at standstill, and the other from the synchronous impedance obtained in the usual manner from the curves of Fig. 6. Of these two calculated curves, the lower one is pre-

sumed to give a near approach to the actual performance of the machine under load; the other, however, gives us merely a somewhat rough approximation of the drop in the armature when in actual operation due to the rate of change of the leakage flux, exclusive of armature reaction. This particular machine, in addition to heavy copper bridges between the poles, had also heavy short-circuiting collars on the magnets; it may, therefore, be assumed that

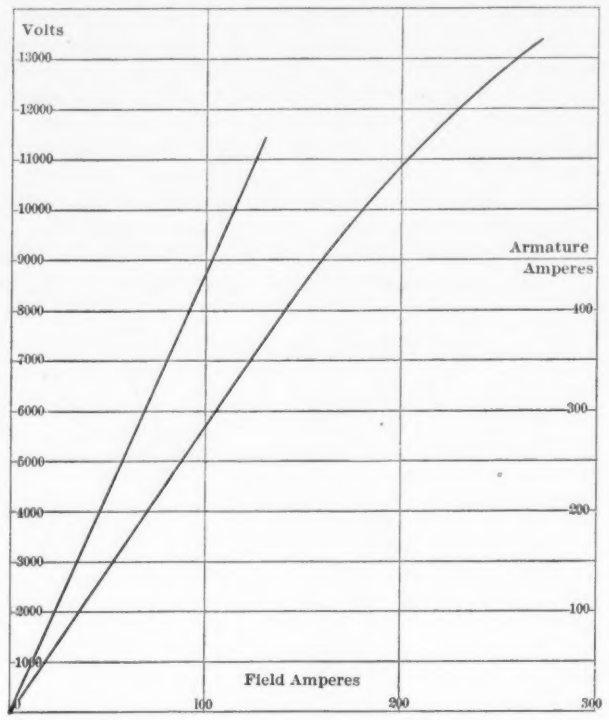


FIG. 6.—CHARACTERISTIC CURVES OF MACHINE (*c*).

the flux due to the armature current during the measurement at standstill did not pass far into the field magnets, but corresponded to some extent to the stray field due to the armature current under load conditions. That this is merely an approximation is plain from a consideration of Fig. 4, where L is seen to vary nearly 100 per cent.

In obtaining the curve in question, shown in Fig. 7, the value of L which was used in the calculation was the average value at an excitation of 190 amperes, found from Fig. 4.

These calculated curves of regulation shown in Fig. 7 are a fair sample of what an alternator will give at extremely low power factors. They are interesting in that they show that in this particular case the diminution in volts due to armature reaction indicated by the difference between the two curves is greater than the inductance drop, which is approximately given by the upper curve. Under true load conditions this would be more pronounced than in the results shown, inasmuch as the true inductance drop when the machine is in operation is in all probability less than that obtained from a measurement of the armature impedance at standstill.

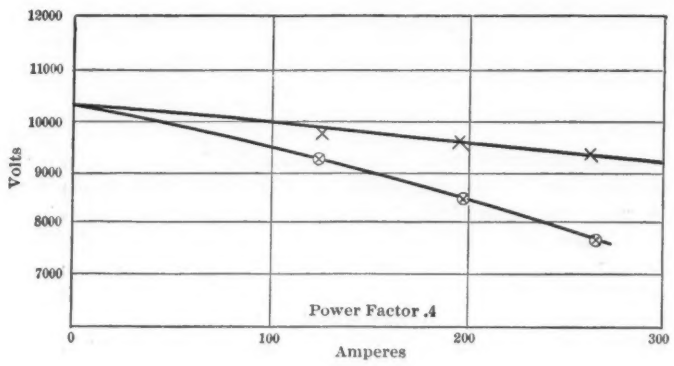


FIG. 7.—CURVES CALCULATED FROM THE MEASUREMENTS MADE ON MACHINE (*c*).

Electric Discharges in Air.

BY ALFRED G. DELL.

IN the following I will give a few ideas formed in experimenting with high potential discharges in air, which can be taken for what they are worth. It appears that the impulses from an induction coil and all high potential machines have a tendency, if no other attraction is present sufficient to hold them, to rush to the extreme limits of all conductors connected to the poles of the machines used in their production.

Suppose there is a point to one pole of an induction coil, and an opposite large sheet of metal without any point attached to the other pole. In this case the discharge rushes as near the point as possible, but the other side of the impulse spreads over the plate with a small accumulation opposite the point; when the spark is made, the charge on the plate being spread all over a flat surface, does not succeed in reaching the spark-gap all at once, but follows in streams in all directions, and as a consequence the spark occupies a longer time than otherwise, which action shortens the spark obtained from the plate side, as compared with the case when two points are used.

It has always been a mystery to me why some think lightning rods should be thin and have a perfect ground connection. Now it is well known that wires when connected to high-potential machines show in the dark more lateral radiation than thicker ones, and as a consequence when lightning rods are thin there should be more danger of lateral discharge than if thicker. I do not consider a perfect ground connection at any time, where a ground is needed, an objection, but do not consider it absolutely necessary with a lightning rod. I would think a moist earth would be sufficient. Consider for a moment the great length of lightning discharge, and the ease with which tall trees are torn to pieces by the discharge passing down the sap of the tree. It is not necessary to go into the action of the discharge producing heat, steam, etc., as that is well known. A moist ground connection would certainly be a far better conductor than the tall tree. A discharge that can pass through miles of such a high resistance as air, and then down the sap of a tree, could certainly pass with ease down a metallic conductor into moist earth.

The Metric System.

President Pritchett, of the Massachusetts Institute of Technology, in criticising the recent attack on the metric system by certain members of the American Society of Mechanical Engineers, says that the statements made as to the survival of old standards in various countries have significance, not in showing the fitness or unfitness of the metric system, but as showing the strength of conservatism, even among an intelligent people. The testimony quoted of an American superintendent of motive power to prove that the English standards of weight and length are used in Mexico, is met with the remark that the Mexican railroads are practically American roads and their equipment is received from the United States. That they should use our standards is as natural, even as necessary, as it would be to use those measures for railroad equipment in the United States. If one were to go outside the mechanical department of these American roads he would find it impossible to do business, except in the metric system. In reply to a statement that nearly all St. Louis real estate is now measured in arpents, because the early French settlers used that unit of measurement, President Pritchett said: "Not only is no piece of real estate in St. Louis measured in arpents, but I question whether among the 600,000 inhabitants of St. Louis a score could be found who even know what is an arpent. As an actual unit of length, it has absolutely disappeared." The argument for the preservation of old and inconvenient standards rests, he said, on no other basis than inertia of the general mass of mankind, and he asked the attention of engineers to the real questions, which, briefly stated, seem to be these: 1. Is a common system of weights and measures for the whole civilized world a desirable thing? 2. Are the benefits to be gained by a universal system of weights and measures sufficient to justify a country in surrendering its present system to adopt such a world system? 3. Is the metric system one fitted to the needs of the civilized world, and has it already gained such general adoption as to make it available as a world system? In conclusion, he said that action by the United States in adopting the metric system would soon lead to similar action by England, thus bringing about a world system.

Telephone Cables.

By Arthur V. Abbott, C. E.

COST OF CABLE WIRE PLANT.

THE expense of telephone cables will vary with the prices of lead and copper, the materials of which they are chiefly composed, and with the electro-static capacity of the completed cable. As different manufacturers use slightly different thicknesses of lead sheath, and as cable for aerial lines is often made with a thinner armor and lighter conductors than that intended for underground service, aerial cables are usually slightly cheaper than those designed for underground lines. Cable prices will also vary, depending upon freight charges from manufacturing centers to the point of consumption.

It is further necessary to allow for cost of splicing and erecting cable either in the ducts, or upon pole lines, and for the cost of terminals. Experience shows the cost of splicing and installing to vary from about 3 cents to about 10 cents per foot, for it is more expensive to splice and erect large fine wire cables than medium-sized, coarse wire ones, and again small cables are more expensive than medium-sized ones. The conductor sizes for all telephone cable are in B. & S. gauge.

Based upon the prevailing prices for copper and lead for 1902, including splicing and erecting expense, the tabular curves shown in Fig. 1 at *B* are plotted. The lower horizontal axis is devoted to the number of pairs, while the left-hand scale is the price per foot in dollars. Three curves are shown, one for No. 19 gauge, from 10 to 275 pairs, one for No. 20 gauge, from 10 to 400 pairs, and one for No. 22 gauge, from 200 to 400 pairs.

For No. 19 gauge cable the electrostatic capacities assumed are .080 m.f. per mile for sizes from 10 to 150 pairs inclusive. From 150 to 275 pairs, .110 m.f. per mile. For No. 20 gauge cable the capacities taken are .085 m.f. per mile, from 10 to 150 pairs, and .110 m.f. per mile from 150 to 250 pairs, and .115 m.f. per mile from 150 pairs to 400 pairs. For all No. 22 gauge cable .120 m.f. per mile is predicated.

By turning the sheet of Fig. 1 around four more curves are found, three on the left hand at *A* and one on the right hand at *D*. The curve on the right hand at *D* expresses the percentage relation between the copper cost, and the total cable cost. The right-hand scale is in per cent., while the horizontal axis gives the number of pairs, the curve showing for the varying number of pairs, the per cent. that the copper cost is of the total cable cost. On the left-hand side three curves are given, showing the weight per foot of the various sizes of cable conductor gauges, Nos. 19, 20 and 22. The left-hand scale is weight per foot, while the horizontal scale gives the number of pairs.

In the nature of telephone business it is impracticable to utilize all of the cable wire which is laid. As the cable extends away from the exchange some wires will be utilized by subscribers nearer to the office than others, thus involving more or less loss of cable conductors beyond. It is impossible for the very best estimate to state exactly the number of conductors needed to serve a given district, moreover from time to time subscribers move from one place to another, thus vacating cable wires in one place and demanding additional facilities at other points. It is in addition always essential to provide a certain surplus of facilities over and above the exact demands of the business, so with the most skillful planning and the best generalship it is impracticable to utilize more than 75 per cent. of the cable conductors laid. Thus in estimating the cost per circuit mile of cable wire, allowance must be made for that which is dead, and while it is sometimes possible to utilize three-quarters of the conductors installed it is pretty safe to assert that to-day not over 50 per cent. of all the cable wire laid is active.

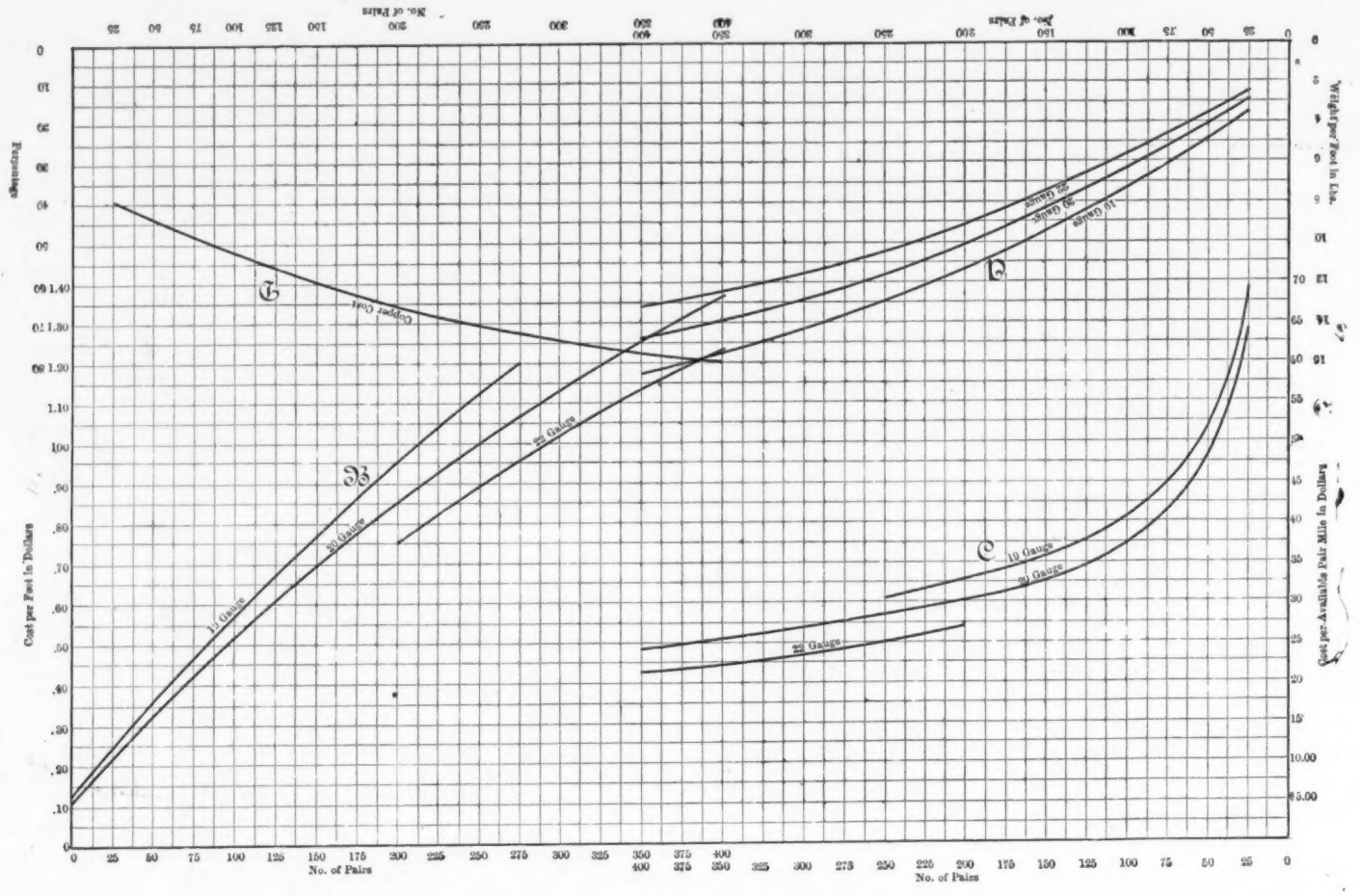


FIG. 1.—CURVES SHOWING COST OF CABLE WIRE PLANT.

In Fig. 1 three curves are given on the right-hand side of the sheet at *C* to facilitate estimating the cost of wire plant, by giving the probable cost per active pair mile of cable wire, based upon the previously specified percentage of working wires. Three curves are given—one for No. 22 gauge, one for No. 20 gauge and one for No. 19 gauge. These curves are the reciprocals of the curves upon the left-hand side of the sheet, divided by 75 per cent.

To estimate the gross cost of cable plant it is desirable to know the total expense per mile of cable laid in place. By a similar train of reasoning to that just given for the existence of inactive cable wire, a certain allowance must be made for dead conduit space, and it is usually estimated that not over 70 per cent. of all ducts laid are actually available.

Fig. 2 gives graphical data showing the total cost per mile of cable of various sizes installed in conduit, costing from 10 cents to $1 per foot, assuming 30 per cent. of dead ducts. For each gauge of wire, viz.: Nos. 19, 20 and 22 a curve is given for each size of cable. The horizontal scale shows the varying cost per duct foot, while the vertical scale is the total cost per mile of cable in place exclusive of terminals.

In Fig. 3 a similar set of curves is prepared, showing the cost per active pair mile. The sheet contains three sets of curves. That at

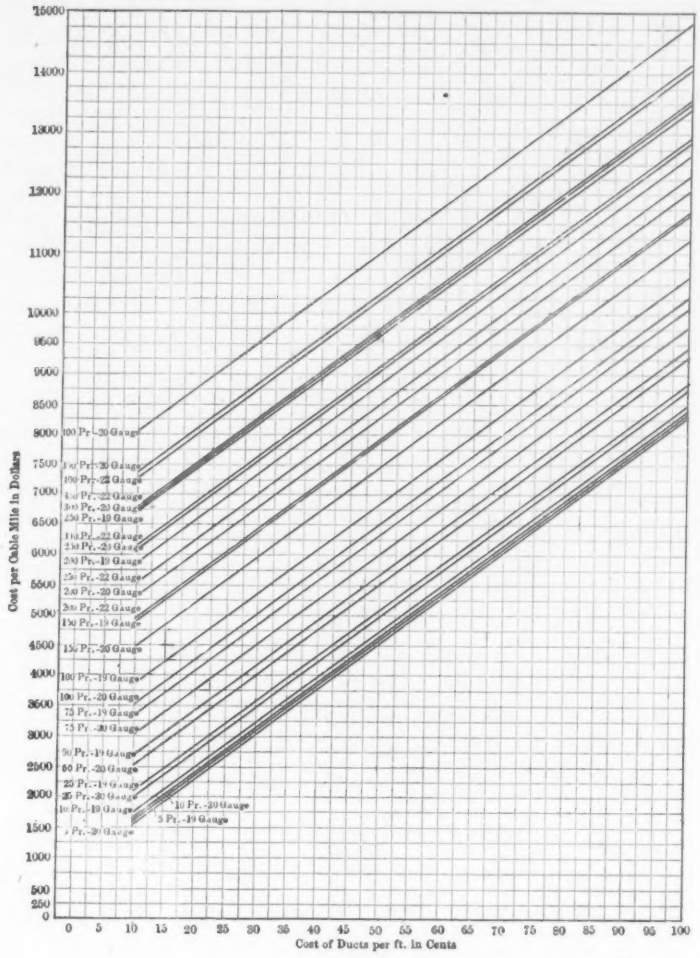


FIG. 2.—CURVES SHOWING COST OF CABLE PER MILE.

A giving the cost per pair foot for No. 19 gauge cable from 5 to 50 pairs installed in ducts, costing 50, 60, 80 cents and $1.00 per foot. This table is valuable in calculating the cost of laterals and terminals, where a cable is taken from the main conduit line and extends to a terminal placed either in a building or on a pole. Usually these lines are short and consequently costs are given per foot of pair circuit. Such lines are always isolated ones and the expense of conduit is very great. The curves at *D* give the cost per active pair mile, for 200, 300 and 400 pair No. 22 gauge cable laid in conduits costing from 10 to 50 cents per lineal foot, as shown on the lower horizontal scale. The curves at *B* give costs of 25, 50, 100, 150, 200 and 250 pair cable No. 19 gauge cable laid in similar conduit. Finally the curves at *C* are similar expressions for cost of cable from 25 pair to 400 pair No. 20 gauge. By means of these three tables an estimate of cost of cable placed under all ordinary conditions of telephone practice, may be readily made, and it is easy to interpolate new rates for any number of pairs between those for which curves are given.

To the costs thus found must be added the necessary expense for terminals. If plain cable heads be used the cost of the head and splicing will vary from $1.00 per pair for small sizes to 20 cents for large ones. Cable heads equipped with protectors (lightning and sneak current arresters) cost from 20 cents to 50 cents per line in addition. Pot-head splices cost from $2.00 per cable for small sizes (25 pair to 50 pair cables) to $5.00 for the large sizes (50 pair to 400 pair). This includes labor and all materials excepting the flexible terminals. Okonite wire for terminals costs from 2 to 4 cents per pair foot. Silk and cotton switchboard cables, 20 pairs, from 15 to 25 cents per cable foot, while wool cable costs from 75 cents to $1.25 per cable foot for 50 to 100 pairs. The cost of forms for cable heads, distributing board terminals, etc., may be taken at 1 cent to 2 cents per wire. The cost of messenger wire for aerial cables, cable boxes, bridle wires, etc., connecting open wire lines, properly belong to aerial construction and will be considered thereunder.

ANNUAL EXPENSES.

The enemy of the paper cable is moisture. Even with the utmost care and in spite of the apparent protection offered by conduit and sheath, underground cables gradually fail. In some cases life is very long, but from one cause and another, owing to extension, necessary re-arrangement of plant, etc., a thousand and one causes operate to injure the cable insulation and deterioration is inevitable and must be provided for, in the depreciation account.

For underground main cable from 5 per cent. to 7 per cent. is a fair annual charge, while for laterals from 8 per cent. to 10 per cent. is essential. Aerial cable is much more exposed to injury than underground lines, for it is a constant prey to all sorts of additional destructive forces—sleet and wind storms, lightning, crosses with high potential wires of all kinds; the small boy with a shot gun or rifle and hundreds of other influences constantly attack it. Moreover, aerial lines have a shorter life than underground ones, as being chiefly erected in districts which are growing rapidly, they are soon superseded by conduit work. For these reasons an allowance from 10 per cent. to 12 per cent. for depreciation for aerial cables is none too great.

MAINTENANCE.

The maintenance to which cable wire is subjected will depend very largely upon the rate of growth in the exchange. Where this is rapid there is a constant necessity for re-arranging and re-modelling

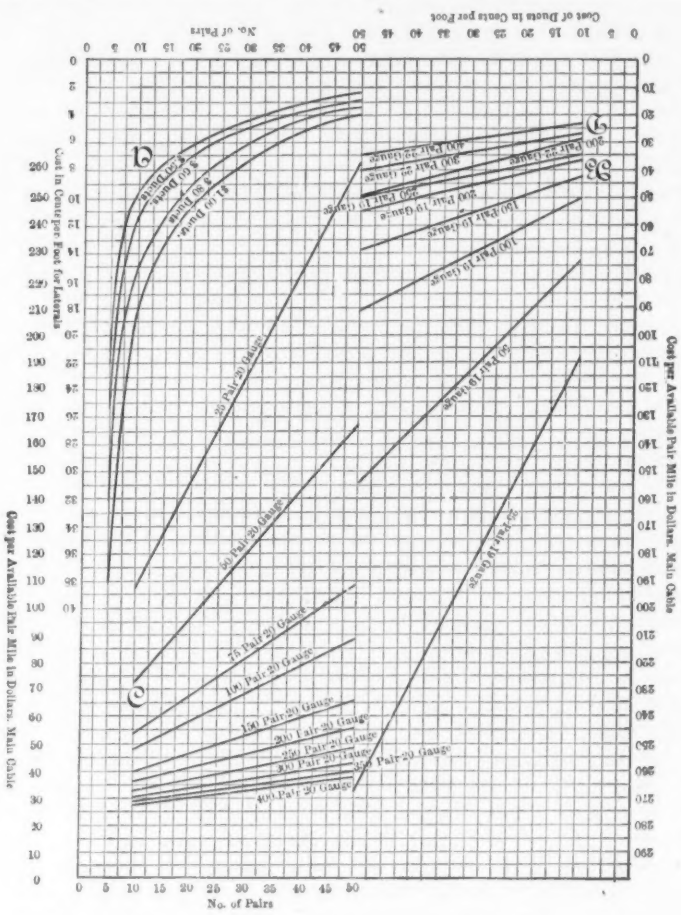


FIG. 3.—COST OF ACTIVE PAIR PER MILE.

cable plant. Under such circumstances maintenance charges will vary from 2 per cent. to 5 per cent. on the cost of installation. For where growth is slow, and there is but little change in districts, maintenance may fall as low as from 1½ per cent. to 3 per cent. With aerial cables 5 per cent. for maintenance is the least charge which should be considered. Combining the charges for both depreciation and maintenance the annual expense for underground wire plant should be taken at from 5 to 10 per cent. for main cables, from 10 to 15 per cent. for laterals, and from 12 to 16 per cent. for aerial cables.

The Progress of Electrical Science During the Year 1902.

BY A. E. KENNELLY.

THE year 1902 has witnessed great development in electric science and in its applications. As a result of experimental research, the ionic hypothesis has steadily gained ground. According to this hypothesis, all electrifications are due to the presence of free or unsatisfied electric charges on atomic masses, in which atomic masses electric charge permanently and inherently resides as a fundamental physical property. Some atomic masses are essentially positive, others essentially negative. The union of the two is atomic combination and accompanies chemical combination. Their disunion effects electrification. Similarly, all electric discharges in fluids and conductive electric currents in solids or liquids are referred, on this hypothesis, to ionic movements in the conducting mass.

As a development of the ionic theory, the corpuscular theory of J. J. Thomson also appears to have gained ground from the experimental research of the past year. On this hypothesis, negative ions are corpuscles, or quantities of matter much smaller than atoms; while positive ions are atoms denuded, or deprived of, corpuscles. A body which becomes negatively electrified without any other change in condition, is a body which has gained in mass by the addition of corpuscles; but the actual addition in mass would be regarded as so excessively minute as to evade all experimental observation.

According to this hypothesis, the fundamental nature of electricity, not yet determined, is essentially enrolled with the fundamental properties of every chip of matter of which each atom is built.

A large amount of research has been conducted in radiography and radio-activity. This science practically owes its existence to the experiments by which Röntgen x-rays were discovered. Radio-activity is a branch of physical chemistry, and, on the corpuscular theory, involves sub-atomic chemistry.

In electro-chemistry much research has been carried on, mainly in connection with practical applications. In fact, the industrial demand for application of electrical energy to electro-chemistry may be said to have created the demand for the application of intellectual energy to the study of that science. A large number of new electro-chemical processes have been devised, and some have already been put into operation. In Nature, chemical change is the sequel of local superabundance of energy, and the art of industrial chemistry naturally develops where energy is cheap and abundant. With the aid of engineering, waterfalls are becoming hives of electro-chemical industry.

A process has already been initiated for electro-chemically producing nitric acid from air, and hence the nitrates which enter into the development of food products. Perhaps this is the furthest existing attempt in the direction of artificial food production by electro-chemical means. Food may be regarded as assimilative substance produced by solar energy acting on non-assimilative substance. Each inland human being needs, on the average, a certain considerable area of soil upon which the solar energy machine can work, during the year, for the production of the food products that he consumes either directly or indirectly through the consumption of some other animal that he finally consumes. The solar energy costs nothing, but the engine in the form of the recipient soil, plants, agriculture, transportation, etc., has very definite expense. The same amount of annual incident solar energy would be enormously expensive to produce artificially; but so inefficient is the solar energy from a pure food-production viewpoint; that is to say, so little of the incident solar energy is actually utilized in the food-engine, that if we only knew how to accomplish the same result simply and conveniently, the necessary energy could probably be delivered to the raw material artificially, at lower final cost than that which agriculture and transportation involve. Nevertheless, the solution of the artificial food problem appears so remote that we must remain content with our thousands of square miles of solar food-engine and our millions of peripatetic food-storing quadrupeds. Every new fact and application of electro-chemistry, or energy-chemistry, may, perhaps, bring us nearer to an ultimate solution of the problem.

Some discussion still continues as to whether a moving electric charge does create a magnetic field in its vicinity. The phenomenon should occur according to orthodox electro-magnetic theory. It is claimed to have been observed by various physicists. It is claimed, on the other hand, not to have been observed, by a few. The weight of the evidence seems to be in favor of the fact. By the same token, the converse proposition should follow, that a moving magnet creates an electric field. This phenomenon does not appear to have been yet recognized.

In the treatment and expression of alternating-current theory, complex quantities, and their geometrical substitutes—plane vectors—have continued to make headway in general appreciation. The algebra of the complex quantity is, *par excellence*, the natural and simple algebra of the alternating-current circuit. If it be discarded, simplicity vanishes and complexity reigns supreme.

Although a great number of direct-current generators and motors have been built and installed during the past year, yet the direction of most rapid advance has been in connection with alternating-current machinery. Pressures are rising steadily, and as the pressure rises, the distance within the vision of supply increases, so that, when the price of fuel in a city is sufficiently high, power can be transmitted thither electrically from falling water at distances that have hitherto been impracticably great. The existing commercial limit is now set in California at 220 miles with 60 kilovolts, and the final limits are not yet encountered. This application of electricity is turning much attention to the study of commercial forms of insulators. The cost of insulation per mile of high-pressure circuit comes into appreciation, together with the cost of conductors and conduction. In a certain sense it may be already said that the range of economical transmission used to be set by the cost of conduction; but now begins to be set by the cost of insulation. Whereas, however, the art of conduction has reached scientific limits that for the present cannot be overstepped, so much conductance calling for so much investment, according to stereotyped rules, the art of high-pressure insulation is much younger, and has not yet apparently reached any definite limit.

In steam power transmission by electricity, the advent of the steam turbine has created some stir during the past year. When harnessed to the steam turbine, the alternator visibly shrinks in dimensions. Already, large sizes of stationary steam turbines are being constructed, and if their performance is as good as their projectors anticipate, we may look for a revolution in central station steam engine construction.

In electric railways, great development has taken place along the standard American lines of the 500-volt, direct-current system. Efforts have been made to break through the monopoly which practice has established for the direct-current system in this direction, and to introduce the alternating-current, long-distance, high-speed railroad motor. The great advantage of such a step, if successful, will be the suppression of the converter sub-stations. The exigencies of long-distance, high-speed railway traffic are such that nothing should revolve save the prime generator at the central station and the motor and wheels on the cars. The cost of equipping and maintaining adequate converter sub-stations heavily handicaps the long-distance electric railway.

While the alternating-current motor has been striving to obtain a foothold in railway work, improvements have been made in the induction motor, whereby its power-factor has been increased and its magnetism has become capable of being produced locally, instead of being produced by dephased alternating currents sent over the transmission lines all the way from the generating station. How fully this advantage can be practically secured yet remains for the future to determine; but there can be no doubt that if the wattless component of currents supplied to induction motors can be conveniently eliminated, the result will be a marked gain in alternating-current distribution. It should be no business of the transmission lines to carry the existing currents of the motors. They should only carry the energy of excitation.

An interesting and significant feature of the times is that the sciences, physics and chemistry on the one hand, and electrical engineering on the other, are growing closer. Engineering depends every day more closely upon these sciences, whence it draws its supplies. On the other hand, physics and physical chemistry are being daily more fully applied to the arts of life under the title of engineering. Consequently the enormous national, industrial and commercial importance of these sciences is becoming more clearly apparent year by year.

The past year has seen the National Bureau of standards placed upon a firm foundation. This important bureau is destined to form

yet another connecting link between science and its applications, electrical, chemical and mechanical.

The metric system has made considerable headway towards public favor during the past year, not only in America, but also in all English-speaking countries. The younger generation, and progressive men everywhere, are for introducing it into general use, as soon as public welfare will permit. In this country, the Congress Committee on Coinage, Weights and Measures has strongly recommended a bill for adopting the system, and the Conference of British Colonies has also recently adopted a resolution in favor of the system for all British colonies. Leading men in Great Britain have recently expressed similar sentiments. Under these circumstances we may reasonably hope for such joint action among English-speaking peoples, in the near future, as will discharge the present incubus of a shamefully unscientific medley in weights and measures, for the simple metric system that has been found to give great satisfaction to European countries. The metric system lessens national labor, dispels fog and assists civilization.

The year 1902 will be notable in electric annals, if only for the reason that it has first seen the electric girdle completed around the world by the successful laying of the Pacific cable. The task has taken practically half a century to accomplish; since the first submarine cable for commercial work was across the Straits of Dover, in 1851. The latest cable in the Pacific, from Vancouver to Fanning Island, is the longest and the deepest cable in the world.

The terrible disaster of the 8th of May last, at St. Pierre, Martinique, is perhaps without a parallel in history. The suddenness with which the city's population was asphyxiated by hot volcanic gases was the appalling feature that stands unique on our records. The disaster made itself felt in electrical circles by the destruction of the cable ship *Grappler* in the roadstead at St. Pierre, and by the breaking of six submarine cables in the neighborhood of the volcano.

The year has also seen the feat of sending messages, by Hertzian waves, over and across the Atlantic, and from Cornwall to Cronstadt on the north and to Gibraltar, Cagliari and Genoa, in the Mediterranean. Even although no industrial use were to be made in the near future of these long-distance messages, yet their achievement is something that will always signalize the year. Wireless telegraphy has made much progress during 1902. Many vessels have become equipped with the apparatus, and various shore stations have adopted the system along the coasts. It seems to be only a question of time when all large vessels will be able to communicate by wireless telegraphy, with lightships and lighthouses throughout the world.

Telephony has made marked progress during the year, and continues to ramify its connections deeper and deeper into the shops, offices and residences of the people. The telephone is becoming ubiquitous, and the saving of time to the community which is thus afforded is enormous, expressed either in money, hours or convenience. Long-distance telephone lines are being cheapened in construction, by diminishing the size and weight of conductor, while adding reactive loads, or inserting reactances at regular intervals. Telephone engineering touches the sciences at many points, and makes great demands upon knowledge and skill.

Fortunate it is that as telephone circuits multiply, they do not tend to obtrude themselves more noticeably on the landscape. In the open country, the wires certainly become more numerous and spread overhead upon poles; but in urban and suburban districts, the more wires there are the cheaper it is, per wire, to bury them underground. Long-distance transmission tends, of course, to suffer thereby, even when the circuits are loaded; but the average service is far better and securer against wind and weather with underground than with overhead wires.

Subsequent to the welcome cessation of hostilities in South Africa, practically all the forces of engineering have been devoted during the year to the amelioration of the world and the uplifting of human existence. In this beneficent joint work, the share of the electrical sciences and arts has been an important one. It means in the United States the daily occupation of more than half a million of workers.

New Electrical Course at Union College.

Mr. Charles P. Steinmetz has been given charge of the electrical engineering department of Union College, Schenectady, and will institute a new course, to go into effect early in the year. Several additional instructors in this department will be engaged.

The Progress of Electrochemistry in 1902.

BY GEORGE P. SCHOLL.

AS the field of electrochemistry is so large and the amount of work done in its various branches is so great, nothing further can be attempted in the present article than to give a general outline of the advance made during the past year. It is evident that the progress, both from a practical and scientific standpoint, has been steady and continuous and that the industry emerges more and more from its experimental stage and is placed upon a solid footing.

Of the events of the past year, probably the most interesting to electro-chemists, as such, in this country, is the formation of the American Electro-chemical Society which has started its career under very auspicious circumstances, and whose membership now is more than 400—a goodly number. It has held two well-attended meetings at which a number of papers were discussed, which are published in Volumes I and II of its transactions. A little later followed the establishment of a journal, devoted altogether to the interests of Electrochemistry, under the name of *Electro-chemical Industry*, which is published in Philadelphia.

In electrometallurgy, at present, the most important branch of electro-chemistry, the number of patents issued in the past year for processes and apparatus of various kinds, bears evidence of a continued interest in the subject. In the domain of the precious metals the electrolytic deposition of gold from the cyanide solution by the Siemens & Halske process appears to be still reigning supreme, though efforts have not been lacking to devise methods which are intended to overcome its most serious drawback, namely the large amount of electrode surface necessary for a successful precipitation of the gold. There has not been as much attention paid yet in this country to the electrolytic process as it merits, but the future will undoubtedly see the Siemens & Halske or some other electrolytic process more largely applied. It is of interest to note that the Wohlwill process for the refining of gold has proven satisfactory in the Philadelphia mint. According to a statement made to the writer by Dr. Tuttle, the chief chemist of the mint, the plant consists of 7 cells, in series, 13 in. long, 11 in. wide and 8 in. deep. The electrolyte is a solution of chloride of gold, containing 30 grammes of the chloride of gold per liter and is strongly acidified with hydrochloric acid. Electrolysis takes place at a temperature of about 50° C. The weekly output of gold is about 5,000 ounces. The voltage at the terminals of the 7 cells is about 4.5 to 5 volts, with a current of 100 amperes.

The problem of obtaining copper directly from its ores by electrolytic methods has been solved very often on paper, but has as yet not found a solution satisfactory to metallurgists. Two interesting papers in this connection have been read by Dr. N. S. Keith (*Transactions* Amer. Inst. Elec. Engrs. and *Transactions* Amer. Electrochem. Society) giving details of the process devised by him, which is said to have worked with satisfactory results on a commercial scale in a plant near New York. Electro-refining of copper, where the superiority of electrolytic over the ordinary methods was first clearly established, has grown to very large proportions, and a series of articles in the London *Electrician* of August 1st and following numbers (abstr. EL. WORLD AND ENG., Vol. XL, pp. 386 and 466) by Philip, on the financial basis and design of Electrolytic Metal Refineries is a valuable contribution to the literature on the subject.

In the metallurgy of lead we find a distinct advance in the successful application of the electric current to the refining of bullion by the Betts process, in a plant having a capacity of about 10 tons daily, located at Trail, British Columbia. The electrolyte is a solution of lead-fluo-silicate, to which, according to a recent patent (U. S. P. No. 713,277, of Nov. 11th, 1902) a small amount of glycerine is added. The anodes consist of the bullion to be refined and the cathodes are thin sheets of lead. The fall of potential between tanks is stated to be only 0.2 volt. The silver slimes obtained in the process are treated at the Seattle Smelting and Refining Works. They average about 8,000 ounces of gold and silver per ton (Ulke. *Eng. Min. Journ.*, Oct. 11, 1902). The reduction of galena as carried out by the Electrical Lead Reduction Company at Niagara Falls, working under the patents of Pedro G. Salom, continues to make satisfactory progress. The process has been described in detail by the inventor in the *Trans.* Am. Electrochem. Soc., Vol. I, p. 87.

The electro-metallurgical treatment of zinc, as well as of nickel ores, has occupied the attention of metallurgical engineers to no small de-

gree, and efforts continue to be made to accomplish it. During the past year several patents have been taken, but nothing has leaked out as to their success in practice. The production of zinc by Hoepfner's process at Brunner, Mond & Co.'s works, Northwich, Eng., is stated to be about 1,000 tons a year and the product is said to be of an exceptional degree of purity. For nickel see EL. WORLD AND ENG., Vol. 39, pp. 476 and 734.

The application of the electric current to the metallurgy of iron still seems to prove an attractive field to inventors, even the name of Paul Héroult appearing among them. This fact seems rather strange, as there is probably no likelihood of the electric current ever replacing the present metallurgical method, except in countries like Italy, Sweden, etc., where coal is very expensive, and where there is an abundance of cheap water power. Of course, the possibility of producing steel or other iron alloys directly from the ores is on the other hand a strong incentive to inventors. The well-known furnace of Stassano, working at 1,500 hp, at Darfo, in Northern Italy, has been modified, and instead of showing the familiar tall stack arrangement, is now constructed in the form of a reverberatory furnace, capable of rotating about its vertical axis. Another furnace, working by the Kjellin process, is to be installed at Gysinge, Sweden, estimated to have an output of 1,500 tons per year.

The manufacture of aluminum has long since passed the experimental stage and has settled down to the slow but steady growth of a well-established industry. In accordance with their policy for years past, the management of the various works have continued their secretive policy and practically nothing about the improvements in their methods of production has reached the ears of the public. As far as the Pittsburg Reduction Company is concerned, it is to be said that some of their fundamental patents run out in a few years, and they are apparently straining every nerve to bring their methods of production to such perfection that on that account alone they will be able to outdistance any possible competitor. They have purchased a large tract of land at Massena, N. Y., where they propose to erect new factories. The demand for aluminum is steadily growing and is sure to continue. Large quantities of it are used in the Goldschmidt process, which is also being perfected on a large scale by its inventor, Dr. Goldschmidt, of Essen, Germany. It will be remembered that this is a reduction process, in which metallic aluminum in powdered form plays the part of a reducing agent, large quantities of pure chromium and manganese being obtained by its help. It is also used largely for welding purposes and repairing castings. Aluminum seems to find more and more favor as a conductor in electrical work, and a number of valuable alloys, such as partinium, etc., are manufactured and find increasing use.

Processes for the production of the alkali and alkaline earth metals by electrolysis have not come prominently to the front during the past year. Early in the year the Darling process for the manufacture of sodium from sodium nitrate, used by Harrison Bros. & Co., of Philadelphia, was described in detail by its inventor before the Franklin Institute, and a considerable amount of it is said to have been manufactured during the year. Lately (*Zeitschrift f. Electrochemie,* October 2nd, 1902) Borchers and Stockum have described a process and apparatus for the production of metallic calcium and strontium, which promises to be of considerable interest. Fused calcium or strontium chloride are used as electrolytes (EL. WORLD AND ENG., Dec. 20th). Phosphorus to the amount of 30,000 lbs. per month is said to be produced at Niagara Falls by the Oldbury Chemical Company, the American branch of Albright & Wilson, of Oldbury, England.

In the processes for the manufacture of chemical compounds by the aid of the electric furnace there is also manifest a steady and progressive development. As the calcium carbide industry in this country is entirely controlled by a single company, its condition was entirely unaffected by the great reaction which took place in Europe, where everybody that could lay hold of a small water power rushed into the business of manufacturing carbide, with the result of an utter demoralization of the trade. According to a statement in *Mineral Industry,* Vol. X, p. 74, it will probably require ten years before the demand for calcium carbide in Europe equals the present manufacturing capacity. There is no doubt that the demand for calcium carbide will increase, as acetylene light is well suited for the conditions existing in many country districts, and calcium carbide is beginning to be used in increasing amount for various metallurgical reduction purposes. A significant statement is made in the London *Electrical Review* of October 10, 1902, namely that the United Carbide Factories of Nuremberg, Germany, are contemplating an action to have the Willson patents anulled in the United States, in order to obtain an outlet for their material on this side of the water.

That indefatigable worker in the field of electro-chemistry, Mr. E. G. Acheson, is to the front again with a new process (U. S. P., 711,031, October 14, 1902) for the production of graphite, an improvement on his former method. The process is based on his discovery that a perfect transformation of amorphous carbon into graphite takes place by causing metallic vapors to act upon the amorphous carbon at the high temperature of the electric furnace. The total yearly production of graphite by the International Acheson Graphite Company, is stated to be about 1,000,000 pounds.

The carborundum industry has also been making steady progress, a third block of furnaces having been constructed at the Carborundum Company at Niagara Falls, and the output of carborundum is to be increased to 1,800 tons per year.

The plant of the United Barium Company at Niagara Falls is being enlarged from 12 to 60 tons capacity for the production of barium hydrate, which is used for various purposes in the arts, such as paints, etc.

Carbon bisulphide continues to be manufactured in large amounts by E. R. Taylor in his improved electric furnace (U. S. P., No. 706,-128, August 5, 1902).

In the field of the electrolytic alkali industry there have been no new developments that have been made public. Kershaw (Lond. *Elec.,* Nov. 28, 1902) states that in Europe about 28,000 hp are utilized in this industry. The severe competition in bleaching powder in Europe has caused a sharp decline in the price of that material, it being even sold as low as $20 per ton in Canada. This contingency has caused the shut-down of the Canadian Electro-chemical Company, Ltd., at the Soo, a company operating under the Rhodin patents.

One of the most interesting processes recently announced is the conversion of the nitrogen of the air into nitrous compounds, and the recovery of these, patented by Bradley & Lovejoy (U. S. P., Nos. 709,867, 709,869, Sept. 30, 1902) and carried out by the Atmospheric Products Company at Niagara Falls. Professor Richards states (*Electrochem. Ind.,* I, p. 22) that the process has worked so satisfactorily on an experimental scale, that the company has decided to start commercially with 2,000 hp. The formation of the nitrogen compounds is caused by the air being drawn through a large number of very thin and very long arcs, which are struck between a large number of stationary and revolving electrodes.

Ozone manufactured in electrical apparatus is fast coming into use as an ozonizing and sterilizing agent for water. Siemens & Halske ozone apparatus has been installed in the water works of the city of Wiesbaden, Germany, which started operation in the beginning of August, 1902, and was followed soon by a second works, of the city of Paderborn, fitted out with ozone apparatus by the same firm. The future will probably see a considerable development along this line.

The ultilization of the electric current for the purposes of electroplating covers such a large field that it is not possible to enumerate the progress made in it in detail. There is, however, a marked tendency apparent in electroplating circles to leave the old rule of thumb methods and run their business more scientifically. The apparatuses are fitted out with current-measuring instruments, so that the conditions are kept perfectly uniform even by unskilled attendants.

Analytical electro-chemistry, involving the use of the electric current for quantitative determinations and separations in chemical analysis, has also steadily advanced. The subject is brought up to date by Dr. Edgar F. Smith, Professor of Chemistry in the University of Pennsylvania, the leading authority on the subject in this country, in the third edition of his book on "Electro-chemical Analysis," which has appeared quite recently. In organic electro-chemistry, probably the most difficult branch of the subject, progress is necessarily slow and it is quite probable that methods are used by various industrial works engaged in the manufacture of organic compounds which have not been made public.

For a time it seemed as if electro-chemistry had less to do with the advances made in storage batteries than mechanical engineering, as the efforts of the constructors seemed all to be bent on perfecting the mechanical construction of the plates in the lead cell and obtaining the greatest electrical effect with as little weight of electrode material as possible. A large number of patents also in the past year have this as their object. According to a statement by

Mr. Hugh Rodman in a paper read before the American Electrochemical Society, the position of the lead cell seems secure for all stationary batteries for central station work, which at present represent 75 per cent. of all the storage batteries manufactured. Another side of the question has been prominently brought forward, however, by the increase in automobilism, for which a light storage battery is a *conditio sine qua non.* A light battery would undoubtedly control all city traffic not on rails. Two batteries which have come prominently to the front, using material other than lead as electrodes, are the Edison and the Welsbach cell. The Edison cell is stated to have been much improved and to be ready to be put on the market in a few months, but no data in regard to it are at present obtainable. The same conditions obtain in regard to the Welsbach cell, of which less, if anything, is known than of the Edison cell.

In the construction of galvanic cells the efforts have been mainly directed at constructing fluid-tight and high-capacity cells, of light weight, evidently with the object of utilizing them as motive power in automobiles.

From the facts stated above it is evident that there has been a continuous advancement all along the line of electro-chemistry during the past year, and there is every reason to believe that the advancement will continue during the year just begun.

Three-Phase Transformers Adopted by the Chicago Edison Company.

It is a matter of no little interest to note that the Chicago Edison Company has adopted for its future work the practice of using three-phase transformers in connection with its rotary converters at sub-stations, instead of the usual American practice of three single-phase transformers connected polyphase. While the use of three-phase transformers is very common in Europe, it has never become popular in America.

Among the principal reasons for its adoption by the Chicago Edison Company has been the saving in floor space and the saving in first cost effected by combining the three transformers in one. The use of a single three-phase transformer makes it possible to connect star fashion the six-phase secondaries, which feed the rotary converters. One terminal of each of the six coils is led out and connected to the rotary converter, and the other terminal is connected to a common neutral, which neutral, if desired, can be connected to the neutral wire of the Edison three-wire network. The connection of the secondary coils for six phases from a single star-connected, three-phase transformer, is much simpler as to wiring connections than three single-phase transformers, connected on a divided delta, to give six phases.

As far as possible, two standard sizes of transformers will be used for rotary converter sub-station work by the Chicago Edison Company. These sizes are 1,100 kw for the operation of 1,000-kw rotary converters, and 550 kw for the operation of 500-kw rotary converters.

With a star-connected, six-phase secondary, the voltage on the secondary is 72 per cent. of the direct-current voltage given by the rotary converter, while with three single-phase transformers, connected on a divided delta, to give six phases, the voltage is 62 per cent. of the direct-current voltage on the rotary converter. There is, therefore, some saving in the secondary wiring, between transformers and converters, with the single three-phase transformers having six-phase, star-connected secondaries.

The 1,100-kw, three-phase transformers will be of the air-blast type, transforming from 9,000 to 182½ volts. They are of the A.B.T. type; this being the abbreviation for "air-blast, three-phase," made by the General Electric Company.

The higher voltage on the secondary before spoken of enables somewhat small regulators to be used. These hexaphase induction regulators are 88 kw for the 1,000-kw units, and 44 kw for the 500-kw units.

The rotary converters for 1,000 kw are 14-pole, 1,000-kw, 214 r.p.m., 250-volt. For a 500-kw unit, the rotary converters have 8 poles and run 375 r.p.m.

Pay for Korean Trolleys.

By way of St. Petersburg, it is announced in a special dispatch from Seoul, that the United States Minister to Korea has demanded the payment of $1,500,000, due to the builders of the electric railroad.

Central Station Progress During 1902.

BY W. S. BARSTOW.

AT no time since the inception of the first central station has development been so pronounced as during the past four years. The introduction of the polyphase system has so revolutionized and extended the limits of electricity supply as to bring about an era of consolidations. To the casual observer these consolidations of lighting and power interests have been consolidations in a financial sense only, and but few realize the physical changes which have taken place in the properties themselves, changes without which present financial results could never have been attained.

Up to within a few years the financier has paid little attention to the numerous electrical developments going on about him because of the one fact that he was unable to satisfactorily compute results. In the early days of the central station it was only the most modern of plants which had any idea whatever of the cost of their output. Poor and good paying customers were considered alike as a whole, and the results were for the most part unsatisfactory. It was soon seen, however, by those familiar with the growth of large industries that to be commercially successful, electricity supply must be put upon a business basis. This basis was soon reached by the adoption of central station measuring instruments, which although inaccurate as compared with those of the present, were a means of correcting existing errors, and the rapid improvements of electrical indicating and recording meters contributed largely to the financial progress of the industry as a whole. The mere fact that the station knew the cost of its output and could compute its income per unit made itself felt in public confidence (where luxury gave way to necessity), and soon electrical engineering was put to the test of supplying a public demand. Such expansion meant the enlarging of the entire central station field. New conditions of demand arose, until to-day a single generating unit represents a capacity seldom found in an entire central station of but six years ago. This means not only new design of electrical plant, but steam plant as well, although perhaps the changes in the former are more noticeable than in the latter.

The recent progress in steam engineering has been marked by increase of boiler pressure, introduction of superheated steam and improved systems of condensing. With increased boiler pressure and superheated steam there naturally arose a demand for more careful design and construction of steam piping, resulting in reduction of condensation losses, by no means a small item of central station expense. The introduction of automatic coal-handling machinery, and the increase in the size of generating units, makes it possible to-day to operate with the same force of labor a central station with fifty times the output of a station of only six years ago. The demands for larger units and the adoption of multipolar generators gave an impetus to low and medium-speed engine development, so that to-day it is the exception rather than the rule to see in a large central station units exceeding a speed of 120 revolutions, whereas, formerly, high speed was almost the universal type.

The development in the electrical plant has been marked by the abandoning of direct-current generation, but by the retaining of direct-current distribution. Machine design and the adoption of alternating-current generation has made possible an increase in generated pressure ten times what it was a few years ago. This increased pressure enlarging at once the area of supply from a common center, introduced, however, a new and important feature in central station engineering, for it became necessary not only to transmit this increased pressure, but to distribute it in much the same manner as the low-tension, direct current of the past. The means whereby such distribution could be positively accomplished brought at once into prominence that device of heretofore second importance—the switchboard.

The switchboard of the primitive station consisted of a few instruments and switches located on or at the side of the small generators with an abundance of fuses scattered throughout the plant. In the early days instruments were considered a luxury and not a necessity, and allowance for "a switchboard" was generally stricken from the estimate of the central station construction budget, while at the present time in the sub-station it necessarily forms as large an item of expense as the total transforming machinery. In the last two years the introduction of high-voltage polyphase current has made the means of control an all-important device and absolute

requirement of modern central station operation. The mere thought that upon it the entire output of a large industry depends, as well as the success or failure of a large financial undertaking, makes the switchboard the heart of the power plant and shows at once its importance and the care with which it should be designed and installed.

It is perhaps in this direction more than in any other that we find the greatest progress during the past two years. The oil switch, the automatic safety devices and measuring and indicating instruments have reached such a point of development as to leave scarcely any improvement to be desired. The details of design have been so elaborated that there seems almost a complication, and yet by the use of secondary systems positive control is easily placed within the hands of a single operator. In many stations—in order to further aid the attendant, by removing possible means of confusion—the controlling mechanism is entirely closed off from the generating room, so that its quiet is comparable to that of a library.

While many changes have rapidly taken place in the generating system, the distributing system has been modified but little. In the underground work the introduction of tile conduits has given a more permanent appearance to subway construction, while extended use of paper insulation has lessened the expense of cable work. In overhead systems the progress has been noticeable in increased strength of material and improved design of fittings, requirements of high-pressure transmission lines demanding special attention in this direction. On the premises of the customer the devices for the use of electricity have multiplied to such an extent that supply of energy for lighting is almost paralleled by requirements for other service. The constant progress of meter development has already permanently removed that "bugbear" to the customer and the central station—the flat rate.

It is on account of this vast progress of the last two years that great care must be exercised on the part of the smaller central station, in that irrespective of its own local surroundings it does not blindly follow in the leadership of the larger plants and go beyond the improvements which have been made to apply to its own conditions. There are to-day many examples where stations have been extensively "modernized," only to find their operating expenses increased simply because their conditions did not call for the extensive changes.

In reviewing the past year's developments one can scarcely see a chance for improvement except in simplification in details of construction and operation, and yet in the light of past progress the central station engineer naturally looks to the future for further developments.

In the transformation of energy from the coal pile to the switchboard, the steam plant of to-day is chiefly responsible for the great losses, the greatest loss being in the prime mover itself. While improvements in the engine have been many, they have been made in detail to comply to new conditions of service and space, and the initial efficiency or reduced cost of operation has not been radically changed.

At the beginning of 1903 no one thing is more attractive as to future possibilities, and which will have more to do with the future progress of electricity supply development, than the steam turbine, which, although recent in commercial engineering, antedates the steam engine in its conception.

The conversion of thermo-dynamic energy in the chain of power transformation of a central station has always been the weak link as far as efficiency was concerned. It is true the use of superheated steam helps and will continue to improve steam engine economy, but this economy is brought about not so much in the engine itself as in the nature of its supply. Steam engine improvements since the time of James Watt have only been mechanical. No one realizes more than the steam engineer himself the little to be gained in the economy of the reciprocating engine, this line of work having been so often reviewed, so that it is no wonder that attention has again been turned to the first steam motors, the reaction turbine of Hero as well as the impact turbine of Branca, a type so familiar in modern hydraulic engineering.

In 1883 De Laval, in connection with the cream separator, developed a steam turbine, at first a reaction wheel but later one of Branca type. This machine was and is still used in cream separators. De Laval spent his energies in securing a complete and adiabatic expansion of steam, and endeavored to convert its entire static into kinetic energy.

In 1884 Parsons developed a steam turbine by allowing the steam by its expansion after admission to the turbine to convert its energy into velocity, acting and reacting on a series of movable and stationary blades. These two are exponents of extreme systems, others taking from each and possibly adding improvements thereto.

The year of 1903 will be remembered as the year in which the steam turbine began its battle for commercial supremacy. That its success will be eventual, there can be no question. It is not surprising that during all the past twenty years of electrical progress, at times almost revolutionary, any radical development in the prime mover should meet with unusual favor. When in the near future the steam turbine supplants the steam engine it will be welcomed by none as heartily as by the electrical fraternity, where small size, low cost and ease and economy of operation will be appreciated. Such a change will again revolutionize the details of construction of the central station. The generator passing from the high-speed to the low-speed type, will again pass to extreme high speed, where requirements other than electrical will govern construction.

This replacing of the steam engine will bring about with it necessary changes in boiler pressure, steam temperatures and vacuum, and will modify more or less all details of steam plant. In the meantime the development in electrical apparatus will continue, as under decreased cost of installation and operation, and the addition of new channels of demand, the whole field of the industry continues to broaden. Each new improvement makes itself felt in changed conditions, so that no one would dare at the present time to describe even prophetically the final "modern central station."

Problems of the Western Telephone and Telegraph Company.

According to reports in the New York and Boston financial organs, the Western Telephone & Telegraph shares are now quoted at about 22, which is equivalent to 16½ for its predecessor, the Erie Telephone Company, as 100 shares of Erie stock were converted into 75 shares of Western Telephone stock, besides having to pay an assessment of $25 per share for Western Telephone preferred at par. Erie Telephone shares never sold below 15, and once sold as high as 122⅜. On the reorganization, $15,000,000 of money was raised to pay off the construction debts, and put $6,000,000 more into new construction.

The Southwestern Telephone Company, the Northwestern Telephone Company, the Wisconsin and the Cleveland companies are understood to be doing a continually increasing business. The Western Telephone Company owns but 70 per cent. in these and also owns $3,600,000 stock, $2,400,000 floating debt of the Michigan Telephone Company, and these assets are problematical. This company was not taken in by the Western when the Erie was reorganized, but was left to future treatment.

The Michigan Telephone situation is rather anomalous. The property is hampered by lack of new money and by floating debt. The bondholders know that more than the face of their bonds has gone into the property and is still there. There are $5,000,000 of Michigan Telephone bonds and $650,000 of Detroit Telephone bonds. It is understood that these bondholders are willing to buy the property at foreclosure and put up new money for extensions. Expert valuation of the Michigan Telephone property shows $9,000,000.

The problem the Western Telephone Company has on its hands is how to finance the Michigan in the future and not carry the whole load. It is proposed that the bondholders shall make some concessions and that the stock interests furnish new money, but the bondholders do not receive the suggestion with favor. They say they prefer to take the property, and there the matter stands. If the Western Telephone Company could realize upon its assets in Michigan or come to some agreement with the bondholders by which new money could safely be poured into the property, Western Telephone shares would have a broader speculative future.

It is said that the Michigan Telephone Company is earning its bond interest and a margin of $100,000 besides, but this is a narrow margin upon which to carry $2,400,000 of floating debt and raise additional construction money. Besides, the constantly increasing demand for apparatus in the territory creates of itself a call for new capital in considerable volume.

The Outlook in Electric Traction in 1903.

BY DR. LOUIS BELL.

THE important work of expansion which has marked the year just past seems likely to continue through the coming season. There is no reason to expect any diminution of the present activity in developing interurban lines of communication unless business conditions should change materially for the worse. If one looks over the work of the past few years it is quite obvious that interurban railways have marked the direction of steady growth. There are good reasons for this state of affairs and for its continuance. Most of our cities are now pretty well provided with street railways, and while many new lines are being constructed or are in contemplation they are in the nature of minor though useful additions to well-established systems. On the other hand, the extension of electric traction to heavy railway working rests rather in abeyance. Conservative railroad men still have many doubts as to the real commercial value of a change of motive power, while freely admitting the feasibility of electric working as an engineering feat. Even were they convinced that substantial economy would result from a change they still would hesitate long before entering upon a programme which would involve changes so far reaching and an increase of investment so formidable.

Most American railways are well known to be greatly overcapitalized, so that they are enormously sensitive to comparatively slight changes in the conditions of general business, and even a change which promised definite economy would receive a scant welcome if it implied a considerable increase in the fixed charges. The merging operations now steadily under way have created a community of interests which adds largely to this natural inertia. Therefore, from a practical standpoint interurban electric traction by independent companies presents the line of least resistance along which growth naturally takes place. Moreover, interurban roads well planned and well built meet a public need, have the moral and material support of the community and have rather uniformly proceeded successfully. They are particularly likely to increase in sections of the country which have been hampered by the unwise administration of monopoly on the part of the steam roads. Hence one sees such great developments as are now in progress in Southern California. In some regions the steam roads have successfully resisted such competition by open and shameless lobbying against franchises or by themselves covertly obtaining franchises to be suppressed or to be utilized only in such way as may serve to avert competition.

On the whole, however, interurban work has a fair field and may be expected to make great headway in the immediate future. Physically, it may be expected for the present to proceed along well-beaten paths. There are, however, two factors which must be taken into account in forecasting the engineering work to be done on interurban systems. First in order of importance comes the possibility of an alternating-current motor system in one form or another. Several such are under trial in this country and abroad with results which are encouraging, but not yet fully decisive. The practical development of any one of these would prove a powerful stimulus in certain kinds of interurban work, notably that which most closely approximates ordinary railway practice.

There are in reality two rather distinct classes of interurban roads. One must be regarded merely as an extension of suburban lines, operating rolling stock which in design, speed, and general functions is not radically different from that in use on the urban systems. The interurban cars, in fact, are here intended to form an integral part of the suburban and interurban service and to share near the termini the same tracks. In such instances there is no immediate likelihood that any alternating motor system will commend itself, by reason of the obvious difficulties in the situation.

The second class of interurban roads comprises those in which uniformity of equipment and community of termini have been sacrificed for the sake of faster and more effective service on the interurban route proper. There is no rigid line of demarcation between these and the former class, but the differences are plain enough to permit of little hesitancy in assigning a given road to one or the other. In case of these larger interurban lines the development of alternating motors has much significance, and while it is as yet too early to venture predictions, it is certain that a good alternating system would greatly facilitate the growth of extensive networks of such electric roads.

On the other hand, a factor is getting to work which may have no small effect on the distribution of power for large systems. The turbo-generator is now prominently before the public, and bids fair to force its way into railway practice to a very material extent. It has three virtues which commend it strongly for use in traction plants. It is generally economical of steam; it gives a good efficiency at moderate loads; and it appears to require relatively little care. In large power stations its virtues are less conspicuous than in small ones where it is put into competition with engines of moderate output, and its best hold in railway engineering would seem to be in equipping auxiliary or distributed stations on extensive systems. Everything which tends to increase the economy of small plants tends to diminish the advantage to be gained by generating power at a single point and transmitting it to sub-stations with rotary converters. Such transmissions are now common, but unless the central station is operated by water power there is considerable room for debate as to the economy of the process. A certain class of distribution cases could certainly be treated to advantage if generating sets of two or three hundred kilowatts could be counted on for the economics which turbo-generators seem to possess. It is assuredly to be expected that turbo-generators will have their chance to make a reputation before another year has closed, and the result may have a very important bearing on future interurban developments.

Quite apart from interurban practice stands the heavy suburban and elevated road traction which is now under way. Of this there is certain to be an increasing amount, probably following rather closely the lines already marked out. Such work stands alone in the service requirements as to acceleration and the uniformly very large output demanded all along the line. At present the third rail seems the only available variety of working conductor in spite of the very serious trouble from sleet which has been most unpleasantly prominent of late. Some method of protecting the rail against this and against the really grave danger to life in case of accidental contact seems essential, but nothing of the kind has yet stood the test of experience.

Again, the complication of the third-rail system in large terminals is of the most forbidding character, and it seems probable that an effective remedy can be found only in reorganizing the current yard arrangements. It is altogether improbable that in such situations a change of motive power from steam to electricity can be accomplished without any changes in methods of operation. Hence the work of re-equipping a big suburban system for electric traction is a rather slow job requiring great caution and finesse, and thus will be undertaken with some hesitation. The next year will show progress in this direction, but probably not to any sensational extent. The policy of those who would be most interested is a waiting one, keeping watch for the results to be obtained in the several large plants already well under way.

Oddly enough, the electric high-speed railway devouring space at a hundred miles per hour or more is actually further in the distance than it was ten years ago. The engineering side of such a proposition, then involving many dubious factors, may now be said to involve no serious difficulties, but the road itself has retreated into the future in spite of the certainty that it could be made operative. The experiments at Zossen that have been so much discussed did clear the way of the one bugaboo that remained—the air resistance. But, as the writer has frequently had occasion to remark, the difficulties of the case are commercial, not technical, and these still remain. Only between large centers of population and over rather long distance would such a road give promise of large returns. Now as a matter of fact, our present steam roads are operated far below speeds that could easily be reached, and an enormous weight of influence is brought to bear against any attempts to quicken running time. To cause the construction of a high-speed electric road requires either conditions of fierce and genuine competition between existing trunk lines, or an independent organization with unlimited resources for lobbying. Neither of these contingencies seems at the present time probable. It is safe to say that if a project for a high-speed line between New York and Chicago were under way, the cost of the franchises and the subsequent litigation would wreck the scheme before a wheel could be turned. The hundred-mile-an-hour train is far more likely, so far as the present outlook indicates, to come into actuality abroad.

Another interesting branch of electric traction—the rural railway—is undergoing marked development, but by an indirect process. The value of electric railways to a rural community has long been understood, at least for the time being. The prejudice against light railways in this country is strong and it has been earnestly fostered by builders of rolling stock and car equipments who find their easiest source of profit in pressing the use of their standard types. It is practically out of the question to find proper equipment for light railways, and hence the real demand for rural roads has been otherwise met. It has, in fact, been filled so far as circumstances have permitted, by minor interurban lines connecting small cities, but gaining no small part of their traffic from the intermediate rural communities. Many roads of this class have been constructed and many more will be in the near future. The need for better rural communications in this country of bad roads is acute, and the smaller interurban roads afford no inconsiderable relief. In this class of work a freight franchise is indispensable if the rural lines are to be of much public utility, and the status of electric roads having such franchises is a matter of grave importance. The interests of ordinary railroads are strongly against freight-carrying electric roads, and the resulting opposition has been and is very determined, but the welfare of the community demands new channels for traffic and they are sure to come. The feeling which exists does, however, tend to rob the electric roads of part of their normal usefulness.

Altogether, the outlook for electric traction is a favorable one, especially as to interurban systems. These, big and little, will steadily increase in importance, albeit the larger projects fall short of the hopes for speed that have been so long current. Several of the interurban lines now built and under construction will run fast trains, but there is nothing sensational in sight as yet. And happily electric railway building is on a far sounder basis financially than used to be the case. There is less exploiting and more building; there are fewer prospectuses and more dividends, so that investors, even in times of relative stress, are more disposed to stand behind a class of enterprises that have become conservative.

The Fire Hazard of Electrical Apparatus.

A disastrous fire broke out in the power house of the Helena Light & Traction Company, at Helena, Mont., on the evening of October 20, completely demolishing the building and nearly all of the machinery, the exception being a number of oil-insulated transformers which were practically uninjured. The building originally contained a steam plant, which has gradually been abandoned, power being purchased from the Missouri River Power Company, which supplies power from Canyon Ferry, 18 miles distant, over a double 11,000-volt circuit. The effects of the fire upon the high-tension apparatus of the Missouri River Power Company installed in the station may be summarized as follows:

The high-tension switchboard, lightning arrester equipment, and, in fact, everything but portions of the six 11,000-volt, 150-kw Westinghouse transformers, were totally destroyed. However, two of the transformers were not upset and, being oil-insulated, their vital parts were protected from the fire. The oil did not burn away sufficiently to injure their coils or cores, and it is probable that it would not have ignited at all had not the covers been removed from the cases, before the fire, to facilitate cooling, the transformers being worked at a heavy overload. The four other transformers were standing on a wooden floor and as soon as the latter was burned away they were upset and poured their oil into an engine pit below.

There were also in the station two 100-hp induction motors driving, through a line of shafting, six direct-current arc light dynamos. The arc machines were totally destroyed, but, from the report of the appraisers, it appears that the induction motors were damaged only to the extent of 50 per cent. of their value. Although the marble distribution switchboard of the station was completely destroyed, there were found behind it three oil-insulated Westinghouse potential regulators in cast-iron cases, which were practically uninjured, the damage appraised being at $20 to provide handles, cable terminals and cleaning up. The results of this fire have demonstrated that oil-insulated transformers are far more immune from injury than almost any other kind of electrical apparatus. It would be necessary, however, to give them solid and substantial foundations to prevent upsetting in the manner indicated or in any other way.

The Outlook for Electrical Apparatus in Europe in 1903.

BY HENRY L. GEISSEL.

HAVING just returned to this country from an extensive trip abroad, I wish to call the attention of American manufacturers of electrical machinery, electrical appliances and electric supplies and novelties, to the great opportunities which exist for the sale of our goods in most of the European countries. There are several markets in Europe which are still "terra incognita" to many of our manufacturers. Though there is still felt a general industrial depression in some of the great manufacturing countries of the Continent, and though the demand for machinery in these countries is not as large and steady as it was some years ago, commerce and industries in these countries are not at a standstill, and orders are still being placed. Unfortunately, the majority of our manufacturers indulge the regrettable habit to neglect entirely and absolutely their foreign customers, when busy at home. As soon as they run short of domestic orders, however, they want foreign trade; and in this fact lies one of the principal drawbacks to the steady expansion of our trade abroad.

I visited during my trip a part of the northern coast of Africa and proceeded then, by way of Gibraltar, to Spain and Portugal. Later I went to France, Belgium, Holland, England, Luxemburg, Germany, Denmark, Norway, Sweden, Austria-Hungary, Italy, the Islands of Sicily and Sardinia, and to Switzerland. In the principal cities of these countries I called upon the leading importers of and dealers in electrical machinery and appliances. I also saw many officials of electric power stations, electric railroads and tramways, electric lighting stations and other plants. The statement which I have made above regarding the shortsightedness of American manufacturers in the way of neglecting foreign customers whilst they get plenty to do in the United States, was not only indorsed by a great number of importing merchants in cities like Madrid, Paris, London, Copenhagen, Stockholm, Berlin, Milan, Genoa and Zurich, but many of them told me, as soon as I spoke about the advantages of our machines, "What is the use of establishing connections now in your country, while your manufacturers do not care for foreign orders. We run the risk of losing our trade in introducing new American machines and creating a demand for them, when your manufacturers, a little later, will refuse to accept further orders."

On the other hand, German and British manufacturers make it a point always to take care of their foreign customers. Another chief hindrance to the development of our foreign connections lies in the fact that the great bulk of all the catalogues sent out from this country are in the English language. We shall never be able to do business of any importance abroad if we do not address the foreign customer in his own tongue, or in a language which he is likely to understand. French catalogues, for instances, can, to good advantage, be used not only in French-speaking countries like France and Belgium, but also in Spain, Portugal, Italy, Switzerland, Luxemburg, Turkey, Greece and European Russia, where the educated class of people generally speak and write French. German catalogues can be used in Germany, Austria-Hungary, Scandinavia and on the Baltic.

On the Continent of Europe the best possibilities for the sale of electrical machinery and supplies exist chiefly in countries poor in coal, like Italy, Sicily, Sardinia, Switzerland, Denmark, Norway, Sweden and Holland. While limited as to fuel supply, Italy and Scandinavia, especially Sweden and the northern provinces of Italy, i. e., Lombardy, Piedmont, Liguria and Venezia, abound in powerful waterfalls; and electricity in those regions is making steady progress. In the mining industries of the Islands of Sicily and Sardinia electricity is also coming more and more to the front. This is also the case in the industrial centers of Spain, such as the provinces of Huelva, Cordova, Asturia, on the Bay of Biscay, and in Catalonia, on the Mediterranean.

In Southern Europe, that is to say in Spain, Portugal, Italy, the islands of the Mediterranean, the south of France and in the countries on the Adriatic, we ought to be able to sell light electric machines, electric novelties and electric fans. It is much easier to introduce and sell these goods than heavy machines. These light and small articles are carried in stock by many importers and wholesale and retail dealers, while orders for heavy machinery are, as a rule, only placed when new plants or works are to be equipped; and in that case the required machinery is generally ordered from the

manufacturer. This is the reason why most of the great German electrical works, like Siemens & Halske, Allgemeine Elektricitäts-Gesellschaft, Schuckert & Co., the Helios Company, W. Lahmeyer & Company, Union Electric Company, and others have their own offices in the principal countries of the Continent, and in many cases have established sub-companies in foreign countries. A good deal of heavy electrical machinery, etc., is also exported by well-known Swiss manufacturers like the Oerlikon Works, Brown, Boveri & Co., and Escher, Wyss & Co. These firms, too, have branch offices all over Europe.

I have no doubt that by taking the right steps we can largely increase our sales in electric machinery in England and most countries of the Continent, but we must go after this business just as energetically and systematically as we do in this country. No manufacturer should think that he can create a demand for his goods by simply sending an English catalogue abroad. This is, in most cases, waste of time and money. Manufacturers of heavy machinery should try to arrange for local representation in each principal country of Europe. There are many American manufacturers who have an agency in London, Paris or Berlin. These offices, however, are never in a position to establish business connections on a sound basis all over Europe. The man in the Island of Sicily who wants to install an electric plant will never go to Paris to get American machinery, nor will the importer in Trieste, Fiume and Budapesth go to Berlin whenever he is in the market for American goods. I have talked these very questions over with hundreds of users of electrical machinery in the various countries of Europe, and they all prefer absolutely to buy from their own countryman who represents American firms, or from the local branch office of the American manufacturer.

Those firms anxious to establish connections on these lines should make arrangements for local representation in cities where the bulk of machinery is handled, and which are, at the same time, first-class distributing points. As those centers I would recommend in Spain, Madrid, Barcelona and Bilboa; in Portugal, Lisbon; in France, Paris and Marseilles; in Belgium, Brussels; in Holland, Rotterdam; in Great Britain, London, Birmingham and Glasgow; in Luxemburg, the city of Luxemburg; in Germany, Hamburg and Berlin for the North, Munich for the South, Breslau for the East, and Dusseldorf or Cologne for the West; in Denmark, Copenhagen; in Norway, Christiania; in Sweden, Stockholm; in Austria, Vienna; in Hungary, Budapest; in Italy, Milan, Turin or Genoa; in Switzerland, Zurich. By a network of agencies thus established there is little doubt that a successful business can be created, especially if we treat our foreign customers in the same way as our own American customers insist on being treated.

Power Development of British Columbia.

Mr. L. E. Dudley, U. S. Consul, reports to the State Department from Vancouver, B. C., on the work being done to furnish electric power for that city and the city of New Westminster, twelve miles away. The object of the company is to join the waters of Lakes Coquitlam and Beautiful by a tunnel two miles long, and provide a permanent source of hydro-electric energy for all purposes. The dam is 405 feet above the sea level, and will be 300 feet long, 50 feet high, 35 feet at the base, and 8 feet on top. In addition to doing this work the company has a gang of men employed in cutting a terrace out of the face of the rock to form a site for the power house. It will be so situated that even if the big dam did give way, the rush of the waters would not affect it. Outside of the company's force there are about 150 employed by the contractors in clearing the portion that is to be submerged, which will make the lake surface 500 acres. The intention is to keep the water always 20 feet above the outlet pipe from the big dam. From the dam down to the power house is a drop of 400 feet in 1,600. Other men are working on the tunnel which will bring the waters of Coquitlam Lake down to Lake Beautiful. In this tunnel the men are boring through solid granite. The tunnel, when completed, will be 2.5 miles long, and will have in that distance a drop of 32 feet. An electric locomotive has been ordered and should now be delivered. This will not be used on the first section of the road from the inlet up, which is a 58 per cent. grade, but will be employed above, to haul the rock out from the tunnel. The transmission line, for which two big gangs of men are now cutting through the forest, will cross the inlet at Barnet. On one side there will be a steel tower to receive the cable. The distance across is nearly half a mile.

Electrical Distribution in the Machine Shop in 1903

BY KERN DODGE.

So many new shops are being erected and so many are being modernized, that the question of the best voltage or system for power and lighting, constantly comes up; and it might be well to say that the question will continue to arise for each plant, as each shop is a problem in itself and must have a solution fitting the particular case at issue.

The power required in the shop is in most cases divided into two classes, viz., constant speed and variable speed. The constant-speed motor is used to run sections of line shaft and some machine tools, such as punches and shears, which require a nearly constant speed. This class presents the least difficulty to the application of the motor.

For constant speed work, the alternating-current motor possesses some marked advantages and its use for this service is satisfactory. Among the advantages which will be gained by installing independent constant-speed motors instead of the line shaft and belt method, may be named clear head room for cranes, portability and lighter and cheaper construction of buildings. Each machine has a particular function to perform and it should be run in such a way that it will do its work in the least possible time, with the least physical exertion on the part of the operator.

Let us consider a special case, say a punch which is running from a line shaft by belt, and we wish to equip it with a motor. Taking the punch first, we find that it is capable of punching a certain sized hole through a given thickness of plate and that the work to be done on this tool is of such size that a hole may be punched at each stroke. The horse-power is determined by the work to be done, plus the friction load of the machine. The current is supplied by a plant already installed and may be either direct or alternating, as the case may be.

Now for the actual running of the machine. We have sufficient data to choose the proper motor to run the tool, remembering that it is perfectly safe to overload the motor from 30 to 40 per cent. at the instant of punching, as the actual time required in punching is but a fractional percentage of the running time, but there are other points which cannot be overlooked, namely, the size, weight and speed of the fly-wheel, for in many instances a motor which will keep the machine in satisfactory operation will not have sufficient starting torque to overcome the inertia of the fly-wheel.

The easiest and best way to determine the power required for any tool is to temporarily belt a motor to it and take careful readings of the ammeter and voltmeter in the motor circuit. But in punch work these measurements will be misleading if the testing motor is very much larger than the actual motor required, for the starting torque of the large motor will start the fly-wheel up rapidly, and this feature of overcoming the inertia of the fly-wheel may be lost sight of.

At last we have found the motor which meets all the conditions, and it must now be attached to the machine. To get the most efficient installation of the motor requires much thought and labor, for a special bracket has to be designed and made, gears or sprockets have to be cut and the motor and bracket must be placed and secured.

A punch is usually considered a constant-speed machine, but if maximum efficiency is aimed at it is certainly proper to secure efficiency in the structural shop as well as the machine shop. If a punch is driven at a speed of say 35 strokes per minute, with light work the operator may punch at each stroke, but if he gets work a little heavier, which permits of only 28 or 30 strokes, then he has to miss every other stroke, which gives the machine a capacity of only 17½ holes per minute as against 28 or 30 if the motor could be slowed down enough to give the punch this number of strokes. We have operated punches on a four-wire system with good results, although the three-top voltages were the only ones ever used, while the rest served only as starting points.

The question of a proper drive for a lathe or boring mill is more difficult and many details have to be considered, such as the class of work which the particular machine has to perform, the material to be cut, the kind of tool steel used, and the strength of the machine. All of these factors are most important because with the new high-speed tool steels, the machines are apt to suffer if they are run to the limit of the tool.

The gear strength of all the gears—and in each combination—must be figured so that the maximum pressure permissible on the tool for a given diameter of work is known for each combination of

gearing. With this data it is comparatively easy to decide on the size of motor which will not injure the machine.

Assuming that a high-speed tool steel is to be used, and that the maximum cuts are to be taken on a certain material, the power required to do this work with a known feed, depth of cut and speed, can be arrived at, fixing the size of motor which will pull this cut.

We now find that we have two values for the power of the motor; one determined by the strength of the machine, and the other by the cut which we wish to take. In almost every case the power required to pull the cut is far in excess of the power which the machine will deliver to the tool post, so that it is necessary to rebuild the machine tool to a certain extent, as there are usually one or two gears which are weaker than the rest of the machine. With a certain combination of these gears, we find the pressure that can be exerted on the tool post is very small as compared with the average of all of the different combinations of gears. If the one, two or three weak gears, as the case may be, are made stronger by using a different material or a wider face, the two-hp values will approach one another, and it is often the case that with a slight modification on the machine, the cutting tool may be operated to its best advantage.

The direct-current motor has great possibilities in speed variation, and there are several different methods employed for varying the motor speed, which we will not consider here except to mention the more important ones as follows:

The two-wire system with field control alone, the two-wire system with a double commutator motor, the three-wire system with its two voltages, either of which may be used to run the motor, and the four-wire system with its six voltages, any of which may be used to operate the motor.

The lighting of the machine shop is most important and not enough attention is paid to it in most cases, no doubt because at the end of the day it is difficult to say exactly how many dollars have been saved, due to good light, or how much has been lost, due to poor light.

It is interesting to note that there is a structural shop with about twenty-four heavy tools and as many motors, which requires just three times the current to light it that is used for power. It pays or it would not be done.

There are arc, incandescent and Nernst lamps, each of which has marked advantages over the others in certain cases, and the voltages and kind of current used for lighting depend upon the choice of these lights.

The steam turbine is coming to the front on account of its simplicity and economy, and as it is best suited to alternating-current generation, the shop of the future will no doubt use alternating current for all constant-speed motors, with a motor generator for the direct-current variable-speed tools which will be operated from a three or four-wire system.

As stated above, each shop has conditions peculiarly its own, and the system best suited to it is the one which operates the constant and variable-speed motors to the best advantage, as well as giving the kind of light which is most efficient.

American Absorption of Paris Lighting Interests.

As already noted in these pages, plans are afoot for the investment of American capital in lighting in the French capital. Messrs. Anthony N. Brady, vice-president of the People's Gas Light and Coke Company, of Chicago; George O. Knapp, the president of the company, and C. K. G. Billings, the chairman of the board of directors, sailed last week for Paris, where they will investigate the problem of combining under one head the various companies that furnish gas and electric lighting to the French capital. The capital required will be more than $50,000,000, which amount, it is said, can be supplied readily by the American syndicate of which Mr. Brady is the chief representative. When seen on the steamer Mr. Brady would not deny the report that he was about to effect a consolidation of the different public utility companies of Paris, but said that it was not an opportune time just now to discuss the matter. "I am not going abroad for a vacation, though," he added. Mr. Billings said that the object of their visit to Paris was to look into the matter of taking over a Paris lighting company whose franchise will soon expire. "The proposition," he said, "came from the French company, and was made to Mr. Brady. We are going over to investigate, and shall return in the latter part of February." The gas company which now lights Paris has a monopoly, and its contract with the city does not run out until 1910. Its capital is 84,000,000f., and the quality of the gas supplied, as well as the method of testing it, is prescribed by law. The dividends are more than 13 per cent. per annum, and surplus earnings are divided equally between the company and the city.

In this connection the following rather vague dispatch from Paris of December 27 will be of interest: After a struggle for cheaper gas, Parisians have now turned their attention to cheaper electricity. In the original concessions to the electric light companies the maximum price was made at 15 centimes a hectowatt, but the companies, by charging for meters, connections, etc., have managed to create charges to the extent of a hundred francs a year. In renewing the contracts the Municipal Council proposes to get even by fixing the maximum price at 8 centimes and eliminating the incidental charges.

Independent Telephony in Wisconsin.

With regard to recent independent telephone development in Wisconsin, Mr. A. L. Hutchinson, of the State Telephone Clearing Company, of Weyauwega, Wis., president and general manager, writes us as follows:

Two companies I have incorporated the past year are not yet placed in the operating field. A third, the Interurban, with Madison as its nominal headquarters, has absorbed the North and East Bristol Telephone Company, of Dane County, the Waterloo Telephone Company, the Lake Mills Telephone Company, and the Wolf River Telephone Company, of Waupaca County. The company now has in operation exchanges at Sun Prairie, Lake Mills, Waterloo, Weyauwega and New London aggregating 600 telephones, and toll lines from Madison to Beaver Dam, and Sun Prairie via Lake Mills to Fort Atkinson, Weyauwega to Waupaca, Weyauwega to New London and Weyauwega to Tustin, aggregating 110 miles of pole line.

A fourth company, the Fox River Valley Telephone Company, of Appleton, which I promoted, and am a director in, and of which I was secretary and manager for the first year, is located at Appleton, Wis. It has an exchange in Appleton of 850 telephones, which is the most complete and up-to-date exchange in the State. The wires are laid underground in the business part of the city and there is a conduit capacity for 3,000 telephones with cables in for 2,000 telephones. This is a central energy system, with double supervisory switchboard. This company has toll lines from Kaukauna to Weyauwega, 50 miles.

I was one of the original incorporators of the Wolf River Telephone Company, one of the very first independent companies in Wisconsin, incorporated in March, 1895, now merged with the Interurban Company. I was also one of three of the promoters and incorporators of the Little Wolf River Telephone Company, which removed its headquarters and management to Fond-du-Lac, two years ago, and which has been in the hands of a receiver since last spring, and which is now being reorganized by the stockholders. This is one of the largest independent companies in the State, and its financial embarrassment was due to a failure of those who got control of the company to supply capital as fast as the demand for telephones required. It has an exchange in Fond-du-Lac of over 800 telephones, with smaller exchanges at Omro, Shawano, Clintonville, Wittenberg and Manawa, and about 500 miles of toll line.

Incidentally I may state that I am also one of the promoters and incorporators, and am at present secretary and general counsel of the Madison and Northeastern Railroad Company, which has under way the construction of an electric railroad from Madison northeasterly as per cut on this letter head. The franchises and rights of way are now being obtained. It is said by the engineers who have been over the route to be one of the best interurban propositions in the United States, as all steam roads in the locality run at right angles to its route, and the whole Fox River Valley has a long roundabout way to get to Madison, the State capital, with from one to two changes of cars. The country is thickly settled, and is very fertile, while the cities all have important manufacturing industries.

The Wisconsin Midland Railroad Company, incorporated by myself with others, to run from Berlin north, on the trolley plan, will be built as soon as financed. It also is a splendid interurban proposition, and is now in the hands of H. C. Hullinger at Berlin, Wis., to finance and build.

Manhattan Elevated Railway Substations.

THE main features of the electrical equipment of the Manhattan Elevated Railway have from time to time been covered in these columns, and in the present article an account will be given in detail of a typical substation. It will be recalled that the system is operated from a main power house at Seventy-fourth Street and East River, where three-phase currents are generated at 11,000 volts, and distributed to seven substations. At these substations the voltage is stepped down to 390 volts and the currents then transformed by rotary converters to direct-current at 625 volts for delivery to the third rail. The maximum installation for each substation is six 1500-kw. rotary converters, each with its group of three step-down transformers, a motor-generator set for starting the rotaries from the direct-current end; two boosters, for controlling the output of two floors of storage batteries, representing a 3,000-kw.-hour capacity, and the complete equipment gives a total nominal output for the station of 16,000 hp. Figs. 1 and 2 are exterior views of the substation at 110th Street, near Manhattan Avenue, in which four rotaries and their auxiliary equipment have been installed. This station also serves as a passenger station, being the only one of the seven not devoted entirely to electrical purposes. Fig. 3 is a section of the station to the east of the main tower. The tower, which is four stories high, contains the passenger elevators and stairways leading to the passenger platform and track sections. The direct-current cables lead from the small tower shown on the left of Fig. 3.

FIG. 1.—SOUTH ELEVATION.

Provision is made in this station, as shown in Figs. 4 and 5, for a storage battery of 204 cells in the sub-basement, and ninety-six cells in the basement. The west end of the basement floor is used as a blower room, and contains the motors and fans for supplying air to the transformers. Sturtevant blowers, driven by 30-hp. induction motors, are employed for this purpose. There is also in this room a small electric pump for furnishing water to the toilet fixtures on the fifth floor of the tower. At the eastern end of the basement floor there is a space 19 ft. wide, running the entire width of the building, which is used as a small machine shop. It also contains lockers for the station attendants. The division of this basement floor and allotment of space is shown in Fig. 5. Stairs located diagonally opposite each other in the front and rear of the building lead from the rotary floor to both the blower room and the workshop.

On the rotary floor provision is made for six 1,500-kw. converters and two boosters. Fig. 6 shows the southwest corner of this station, with rotaries one and three in position, and a section of the transformer gallery and the location of the transformers with respect to the converter. A ladder leads from the center aisle of the rotary floor to the gallery, as well as the spiral stairway at the northeast corner of the building. Fig. 7 shows the transformers and wiring of these machines. In the front of the building, close to the south wall, is located the auxiliary starting set, which is illustrated in Fig. 8. A plan of the first floor is shown in Fig. 9, and a plan showing the transformer gallery and rotary floor is presented in Fig. 10.

Each rotary converter is supplied with alternating current from three step-down transformers of 550-kw. each, connected in delta. The voltage of the current supplied to the transformers is not uniform throughout the system for obvious reasons, but provision is made for adjusting the ratio of transformation by means of loops brought out from the primary windings so that the potential of the direct current delivered by the rotary converters shall be equal. The transformers are air-cooled, and the necessary air is supplied by motor-driven blowers, which are installed in the basement. A comprehensive system of air ducts serves these transformers with air.

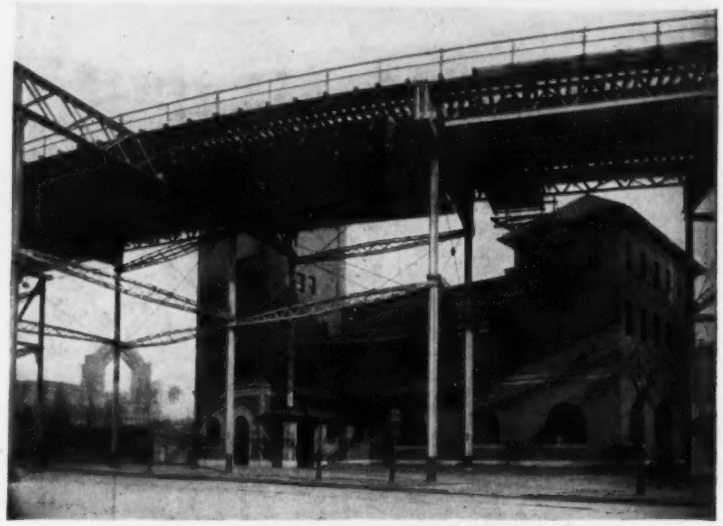


FIG. 2.—GENERAL VIEW OF SUB-STATION.

The guaranteed efficiencies of the transformers are 97.75 per cent. for full load, 97.70 for 25 per cent. overload, and 95 per cent. for quarter load. The rise in temperature for a 25 per cent. overload run for twenty-four hours is guaranteed not to exceed 450 C. In performance the transformers have far exceeded the guarantee, as have also the rotaries, whose efficiency was guaranteed at 95.75 per cent. for full load, 96 per cent. for 25 per cent. overload, and 89 per cent. for quarter load.

From the switches that are mounted on the marble panel on the front of each transformer, as shown in Fig. 7, six heavy cables are lead directly through the gallery floor from each group of transformers to the alternating-current terminals of its respective converter. The voltage of the current supplied to the rotaries from the

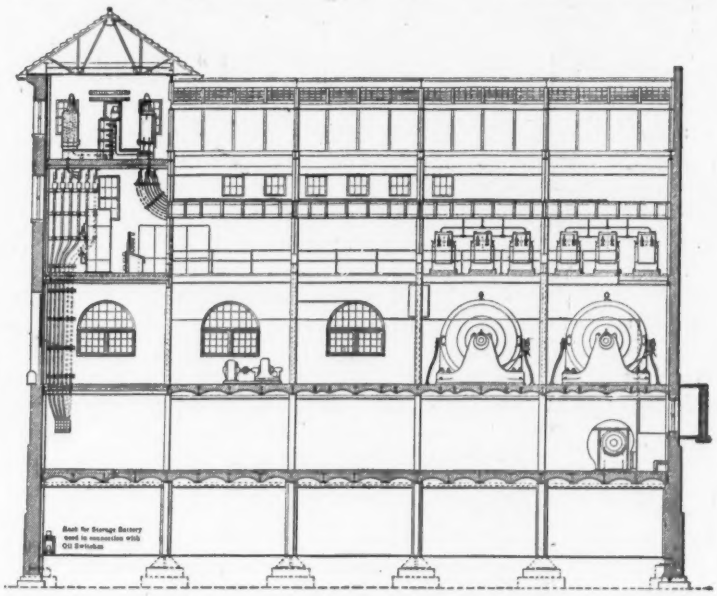


FIG. 3.—LONGITUDINAL SECTION.

transformers is relatively low, and 1,250,000 circ. mil cables are employed for this service.

The rotary converters are larger than any that have heretofore been constructed, having a nominal rating of 1,500-kw. and maximum capacity of 2,250-kw., or 3,000-hp. Each converter is a self-contained unit, the two bearings and the lower half of the field frame being mounted on a common base. The field frame is divided in a horizontal plane to permit access to the windings. They are 12-pole

machines, and when supplied with an alternating current of 25 cycles per second will operate at a speed of 250 r.p.m. The field is compound wound, the shunt winding being arranged for self-excitation. The output of the converter, as stated above, is delivered at a normal potential of 625 volts. The winding is of the parallel type, forming twelve circuits, and is cross-connected by balancing rings. With a potential of 625 volts across the direct-current terminals the average difference of potential between two commutator bars will not exceed 12 volts. The converters are guaranteed to stand an overload of 100 per cent. without "hunting," and may be overloaded to several times the normal full load without falling out of step. In the construction of these converters the fly-wheel effect has been made relatively small and that of the copper damping shield is powerful enough to have the controlling effect upon the armatures of the converters. The total weight of each converter is about 53 tons; the height is 13½ feet and the floor space occupied 13 x 10 feet.

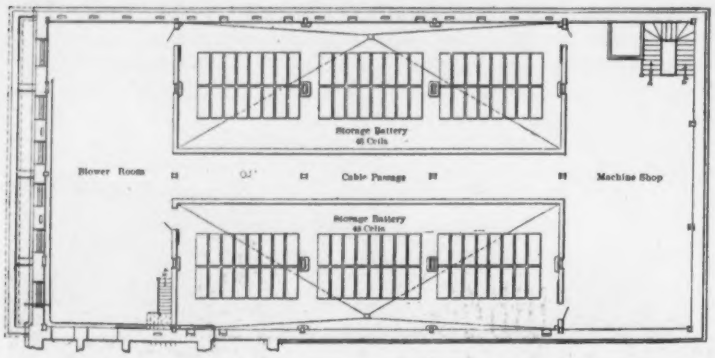


FIG. 4.—PLAN OF BATTERY PLANT IN BASEMENT.

The converters are started by direct current. A motor-generator set (Fig. 8) is installed in each substation for furnishing the current for that purpose. The method of starting by direct-current derived from these starting sets, rather than by direct-current taken from the main bus-bars of the substation, was determined upon to avoid undue magnetic and electrical strains in the converter, such as may easily result from a slight mistake of the operator, for example, in closing the synchronizing switches when the machines are not exactly in phase.

A single set of bus-bars is placed in isolated brick compartments, with incoming feeder switches to one side of the bus-bars, and outgoing rotary converter switches to the other side. The bus-bars are divided by knife switches into sections, one for each rotary converter, so that any section of the bus-bars may be shut down for repairs.

Each of the three conductor cables carrying high-potential current from the power house to the substations is equipped at the power house end with an oil circuit-breaking switch, with a time limit relay device, and in case of a short circuit in the cable the supply of current from the power house would be interrupted at the end of a predetermined interval. At the substation end the cable is connected to the bus-bars through a similar oil circuit-breaking switch, but in this instance the switch will open automatically in case of a reversal of the current, such as would be caused by a short circuit in the cable. Again, in each high-potential alternating-current circuit which connects the bus-bars at sub-stations with a group of step-down transformers, and through them with a rotary converter, an automatic circuit-breaking oil switch with time limit relay has been placed, and in the direct-current circuit between the converter and the direct-current bus-bars the circuit breaker has been arranged to open the circuit should power exceeding a certain predetermined small amount flow back through the direct-current bus-bars into the converter. In case of a short circuit in the group of transformers, in the converter itself or in the connecting circuits between the alternating-current circuit breaker and the direct-current circuit breaker, provision is made for these breakers to act automatically and disconnect from the alternating-current bus-bars

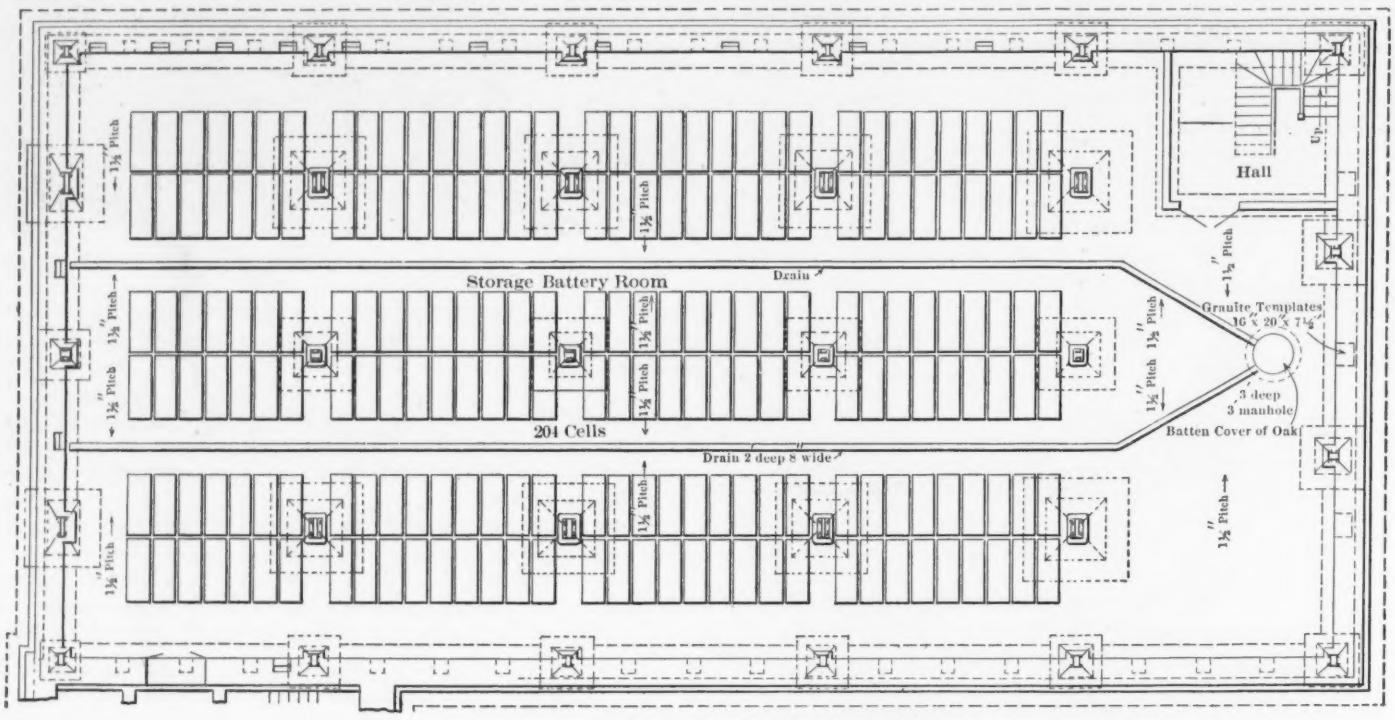


FIG. 5.—PLAN OF BATTERY PLANT IN SUB-BASEMENT.

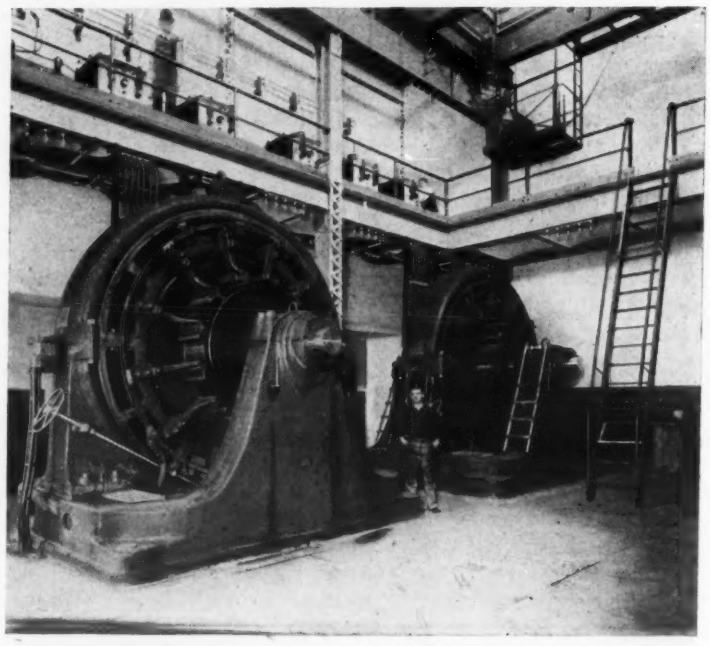


FIG. 6.—TRANSFORMER GALLERY AND TWO OF THE ROTARIES.

and from the direct-current bus-bar the converter unit affected.

The switchboard, Fig. 11, is located on the gallery at the eastern end of the station, and consists of a direct-current board of the usual type, with its end panels placed at right angles to the panels forming

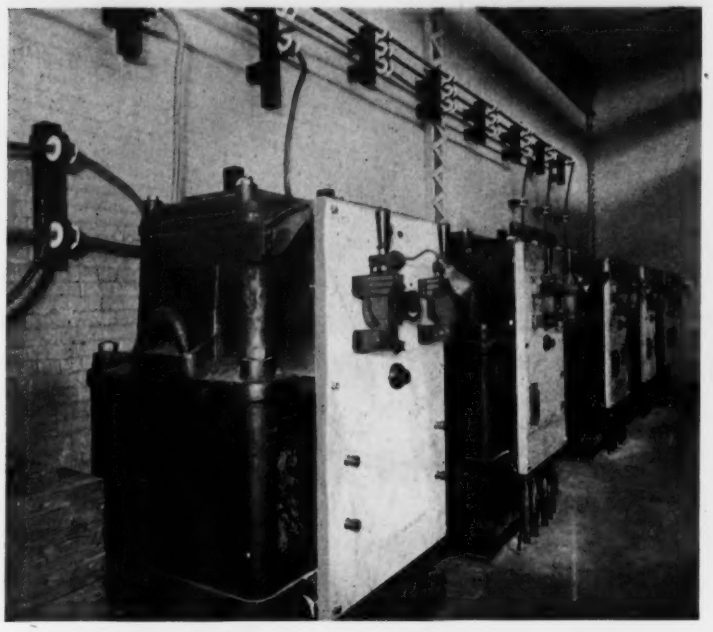


FIG. 7.—TRANSFORMERS AND WIRING.

the central portion of the board, thus enclosing on three sides the operating bench board. The alternating panel board and the operating bench board are illustrated in Fig. 11. Each incoming feeder and each rotary converter has a controlling switch, with visual signals

up to 3,000-kw., one power factor meter and one ammeter. Over the central section of the board a higher panel carries one main voltmeter, one synchronizing voltmeter and two synchronizing lamps.

Switches are provided in the circuits between transformers and converters, and they are mounted upon marble panels carried upon the step-down transformers, as shown in Fig. 7. The panels are equipped with a synchronizer and a synchronizing lamp, and another synchro-

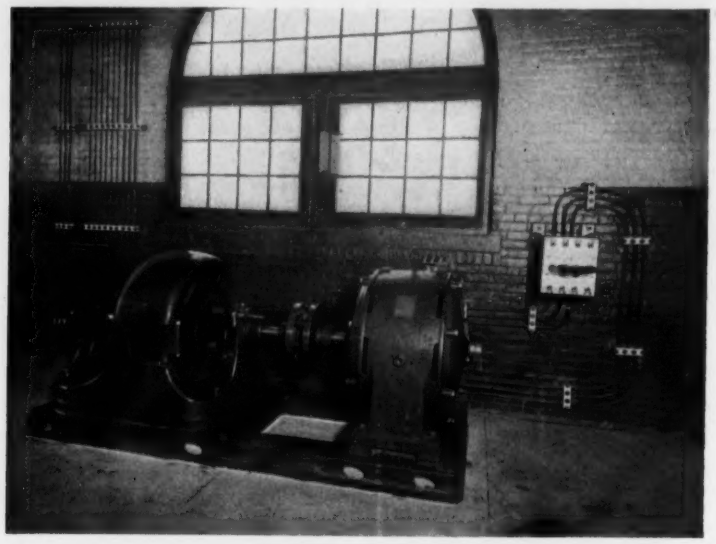


FIG. 8.—AUXILIARY STARTING SET.

nizing lamp in the same circuit is provided for the switchboard at the end of the sub-station for the convenience of the operator at that point in adjusting the speed of the converter to be synchronized. Induction recording wattmeters and the relays for automatically opening

FIG. 11.—GENERAL VIEW OF SWITCHBOARDS.

arranged diagrammatically on the face of the bench board. On the panel rising above the back of the bench board are the alternating-current instruments. There are no instruments for the incoming line, but each converter has one indicating wattmeter, with a scale reading

the oil switches in case of accident are mounted on the rear of the operating bench board.

One reverse-current relay for each incoming line, and one time-overload relay for each rotary converter are provided. Each con-

verter is also provided on the switchboard with one Thomson recording wattmeter, an ammeter, reading up to 5,000 amperes, and a circuit breaker designed to carry 6,000 amperes. This circuit-breaker is of a new type, without the usual tripping coil, the magnetism for the tripping device being obtained by means of the steel bar surrounding one of the studs, which greatly simplifies the breaker. It is fitted with an easily removable cover over the secondary contacts, and attached to

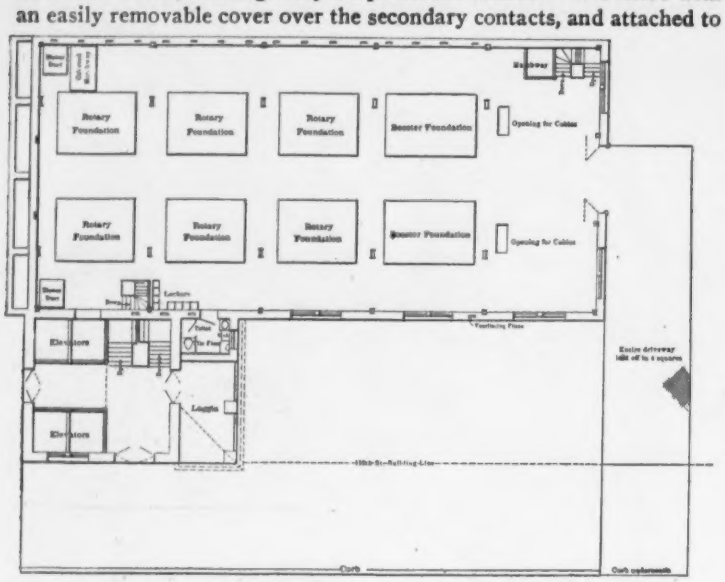


FIG. 9.—FIRST-FLOOR PLAN SHOWING ARRANGEMENT OF ROTARIES.

it is a reversal device for tripping the breaker when power exceeding a certain amount tends to flow back over the line into the converter.

Reserve panels, fitted with reserve circuit breakers, one for each of the rotary converters, and outgoing feeders will also be provided. The reserve panels will be connected to auxiliary bus-bars, as indicated in the diagram of connections, so that in case a circuit breaker gives trouble a reserve panel, with its equipment, may be substituted by throwing the main switch on the converter or feeder panel into another position.

The connections for the motor-generator set for starting up the rotary converters from the direct current end, are so arranged that a converter may be thrown on to the starting bus and brought up to speed while other converters are running across the main busses. Suitable switches are provided for connecting the field of a converter to be started outside the starting resistance. The field rheostat of the

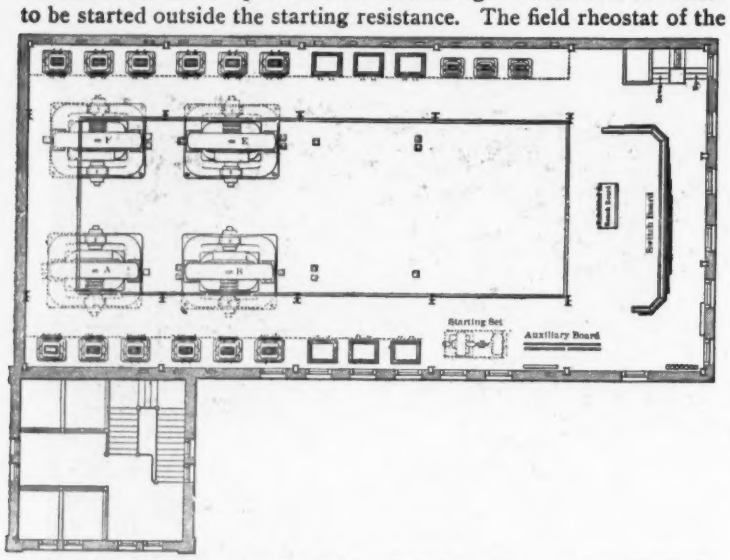


FIG. 10.—PLAN OF GALLERY WITH TRANSFORMERS AND SWITCHING APPARATUS.

starting generator is mounted on the alternating-current operating bench board, so that the attendant may accurately adjust the speed of the rotary converter while synchronizing. A switch is also provided on the bench board for tripping the circuit breaker of the starting generator the instant the converter is thrown into the circuit on the alternating-current end.

The rotary converters, static transformers, motor-generating sets, boosters and induction motors for driving the blowers were supplied by the Westinghouse Electric & Manufacturing Company, and the switchboard equipment by the General Electric Company.

New York to Boston by Trolley.

Various amateur and experimental trips between New York and Boston by trolley have been made—with one or two short links left out, but now a definite plan is said to have been worked out for a continuous "all trolley" route. Plans are now completed, the companies incorporated, and the capital found for the construction of the final link in a system of trolley roads connecting Boston with New York City. This is a line from Hartford to New Haven. The backers will be Gay & Co., bankers, of State Street, Boston, and James F. Shaw & Co., another banking firm of that city. These promoters, who jointly control some $40,000,000, are the principal stockholders and have controlling interests in two proposed lines between these hitherto unconnected cities, one running direct and the other via New Britain, Plainville, Southington and Cheshire. When the charter applications are made at the next session of the Connecticut General Assembly, it is reasonably certain, the assertion is made, that one of the two will be granted. Both the Gay and the Shaw interests are already operating roads in Western Massachusetts, among others being largely represented in the line connecting Worcester with Boston.

In the make-up of the through line this Boston-Worcester road will be the terminal. Between Worcester and Rockville, Conn., a 40-mile line is rapidly nearing completion. From Rockville to Hartford are the lines of the Hartford, Manchester and Rockville Street Railway Company, making an unbroken system from the Hub to the Connecticut capital. Then comes the break which the Boston firms are now planning to span.

Beyond this, from North Haven, through New Haven to Woodmont, run the tracks of the Fair Haven and Westville Street Railway Company, and from there on the Connecticut Railway and Lighting Company, controlled by the United Gas Improvement Company, of Philadelphia, carries the line through Bridgeport, the Norwalks, and Stamford to Port Chester, N. Y. From there the New York and Port Chester Road, which has recently gained the right of way for a four-track rapid transit system from the terminus of the New York City subway to the Connecticut line, will complete the through system. This latter road will overreach the Greenwich line, owned and operated by the New York, New Haven and Hartford Railroad Company, with which the latter for some time has completely blocked the plan for a through trolley from Boston to New York.

From Boston to Hartford the Gay and Shaw interests will be the controlling factors; from Woodmont west to Port Chester, the Connecticut Railway and Lighting Company, owned in Philadelphia, and from there on into New York City the Port Chester road. The Fair Haven and Westville Street Railway Company thus far has remained independent, but it is believed to be only a matter of time when this will be absorbed by the ever-growing Connecticut Railway and Lighting Company. In Hartford also there is an independent line in the form of the Hartford Street Railway Company. Just what traffic arrangements will be made between these roads is still to be made known, but it is certain the fare between Boston and Manhattan will be materially under the steam prices.

For the entire distance the trolley will practically parallel the Consolidated Road. However, the hostility of the steam interests is beginning to wane, and it is becoming more and more apparent that the electric lines not only serve as feeders for the steam, but build up suburban populations and bring bigger returns for both classes of roads.

New York Elevated.

The New York State Board of Railroad Commissioners has been taking evidence as to the congested condition of street car and elevated traffic. President Cole states that the public protest had convinced the board of the necessity of an investigation of the traffic conditions. He has summoned the officers and directors of the "L" road, who will be put under oath and be compelled to testify as to the existing conditions. He has promised on behalf of the board that New York would be given temporary relief as quickly as possible, and then permanent relief. The development of traffic under electricity has been enormous and phenomenal.

Independent Telephone Work in Canada.

Note was made some time ago in these columns of the development of plans for a telephone exchange system of the most modern type at Port Arthur and Fort William, Ontario Province, Canada. One feature of interest is that these twin exchanges have been established by the municipalities of each town, where a system exists already, so that there is municipal competition set up. Another interesting feature is the fact that the contract was placed in the United States and was given to the International Telephone Mfg. Co., of

FIG. 1.—EXCHANGE BUILDING, PORT ARTHUR.

Chicago, to whose president, Mr. Henry Shafer, we are indebted for the details now given.

Both towns own and operate their own electric light plants, water systems, and the town of Port Arthur is operating the street railway system through and connecting the two towns. In establishing the telephone systems it was intended to place the exchanges upon a basis that would leave no profit after paying operating and maintaining expenses, interest on the cost of the plant and a proper allowance for depreciation. This was done to avoid taxing the subscribers for the benefit of non-users, so that taxpayers of the towns who were not subscribers would not be required to bear any part in the cost and expense of the plant. Considering the economy of operating and maintaining the plants in connection with the other allied systems, it was estimated that a safe basis of rental was $1 per month for residence and $2 per month for business service. Both exchanges are of the same size and equipped with same style system

The plant at Fort William is built entirely distinct from the other electric systems. The plant at Port Arthur is built with the line wires occupying the same poles as the electric light circuits and street railway lines. The first building at the right, in Fig. 1, is the exchange building at Port Arthur. The municipal pole line is seen at the right of the street. The telephone wires are placed at the top of the poles, while 2,000 volt alternating current electric light circuits

FIG. 2.—TRUNK LINE BETWEEN PORT ARTHUR AND FORT WILLIAM.

are attached about eight feet below the lower telephone wires. Fig. 2 shows the trunk line between Port Arthur and Fort William. The telephone wires are placed about six feet above the 500-volt direct-current street railway feeders on the same poles. The telephone wires are transposed every fifth pole.

The line wire was secured from Germany, the poles and other construction material were purchased in the Dominion, and the telephones and switchboard equipment in the United States from the International Telephone Mfg. Co., which also completely installed the central office equipment. The Port Arthur exchange switchboard is shown in Fig. 3. It is a strictly central energy lamp signal trunking board, with double supervisory clearing-out signals, pilot lamps, etc. It is built in a regular multiple switchboard frame and cabinet and so arranged that when the number of subscribers increases and extensions are required above the number that two operators can handle, necessary multiple jacks may be installed and the board readily made into a full multiple switchboard without discarding the original installation. The board

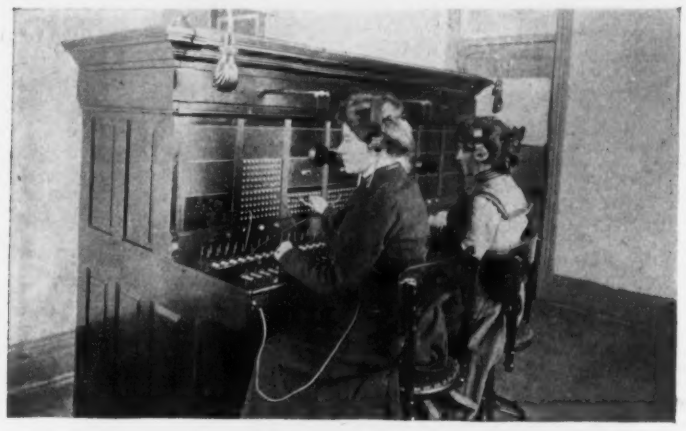


FIG. 3.—SWITCHBOARD, PORT ARTHUR EXCHANGE.

shown is equipped with 280 subscribers' lines, 140 to each position. It is arranged so that 60 lines, or even more, may be added to each operator's position and additional positions or selections added at any time.

Fig. 4 shows a section of the board and the parts more in detail. The key-shelves (one of which is shown turned up) are made of a veneer of five layers of wood, securely glued together. The ringing and listening keys are mounted on the bottom of the shelf with the levers extending through nickel-plated swivel escutcheons mounted on the top. All terminals of the International key are at one end, which makes it possible to have all wires made up in one cable form, leaving the platinum contact points free and open for inspection.

On the closed key-shelf is shown one of the line signal lamps and holder. The holder is an opaque insulating tube with an opal set in a brass cap. It is provided with slots at the opposite end from the opal, leaving the terminals of the lamp exposed when inserted. The opaque

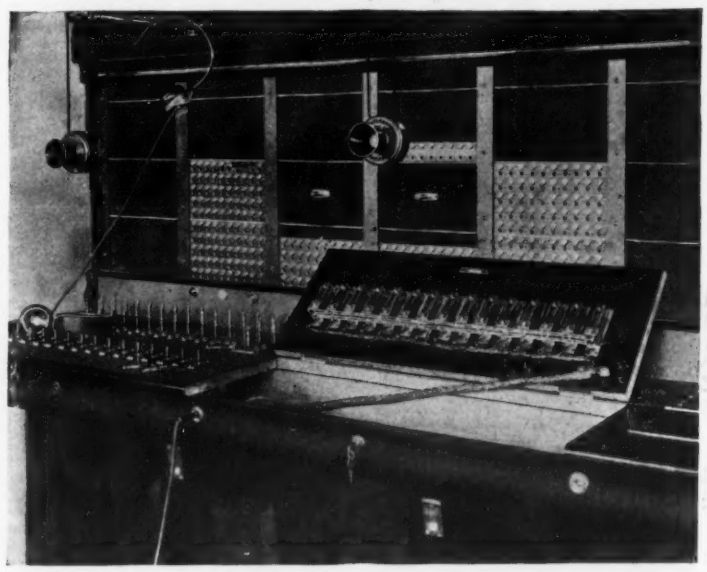


FIG. 4.—SECTION AND DETAILS OF BOARD.

tube and lamp are very easily placed in the bank of lamp jacks direct from the front of the board, as is shown in the top left bank. The lamp being enclosed, all the light is confined to the one opal, which prevents any possible chance for a mistake as to the right signal.

The line lamps are mounted in jacks built in strips of ten. The springs of the jacks are made of the best sheet spring German silver. They are provided with a formed projection, so that they make a good point connection with the base of the lamp when inserted.

The springs are set into a hard rubber strip and firmly clamped with a brass strip insulated with mica. The spring block is fastened to the front piece with heavy brass studs. The front piece is a heavy brass rail, faced with hard rubber, with the proper holes for receiving the lamps with holders. Each end of the front rail forms a flange which is set into the iron switchboard frame and to which the banks are clamped from the front with a bolt and nut.

The spring jacks, which correspond in number with the line lamps, are also mounted in strips of ten. The front piece of the bank of

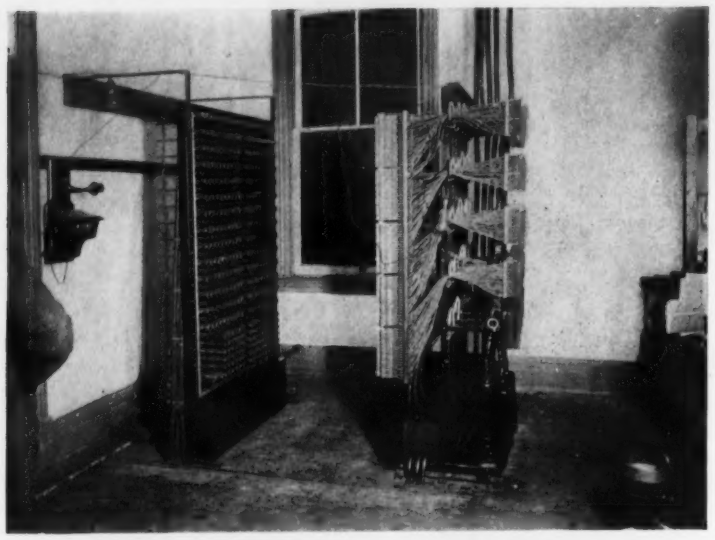
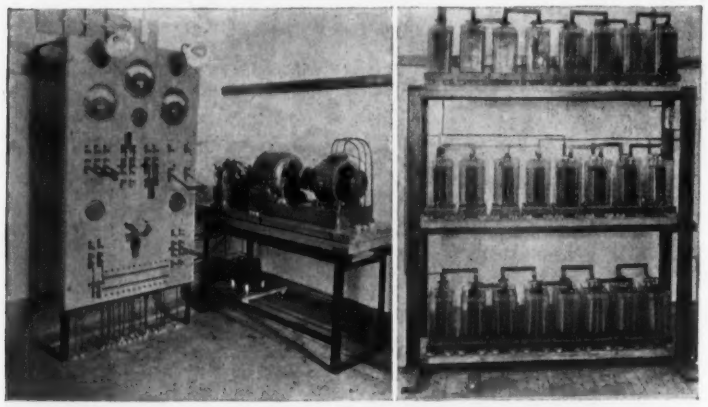


FIG. 5.—RELAY RACK, DISTRIBUTING AND ARRESTER RACK.

jacks is made of a veneer of hard rubber, front and back, with a brass rail for its center. The holes in the brass rail are of sufficient size to receive a hard rubber bushing before inserting the jack ferule. The brass rail provides a means for firmly clamping the banks of jacks to the iron frame, and also makes the banks strong and durable.

A pair of supervisory signals are placed in the plug board directly in front of each pair of cords. The clearing-out lamps are mounted in tubes similar to the line lamp holders. These tubes are provided with an opal holding cap on which is placed a small arched wire guard which prevents the opal being broken by impact from the plugs and also serves as a means for conveniently taking the tube, with



FIGS. 6 AND 7.—POWER SWITCHBOARD AND STORAGE BATTERY PLANT.

lamp, from the socket. These are removed from the top of the plug board, as is shown in the second pair at the right.

The plug board and the pilot lamp panel located back of the plugs are covered with heavy belt leather. In the center of the board, between the two operators' positions, are mounted the trunk signals and trunk jacks connecting the two exchanges The board is provided with a key, so that at night, when but few calls are received, the battery power ringing generator may be switched on at any time and operated only when required.

Fig. 5 shows the relay rack and the combination distributing and lightning arrester rack, with heat coil and carbon arresters. On the relay rack are mounted all the line relays, supervisory and pilot relays and coils. The relays are securely mounted on iron strips, supported on an angle iron rack. The relays are securely enclosed in a dust-proof brass shell. Fig. 6 shows the power switchboard, the charging machine with an alternating-current motor, the main ringing machine, with alternating motor, and the auxiliary ringing machine. The auxiliary ringing machine is operated from the storage batteries The marble power board is supplied with a charging circuit ammeter, a discharge circuit ammeter, a volt meter, voltmeter switch, starting boxes, field rheostat, circuit breaker, bus bars and all necessary copper knife switches for properly controlling the entire system. The power tables are made from angle iron and are strong and rigid. The top is of a thick maple slab, supported on soft rubber balls, set in a maple frame, mounted on the top of the iron rack.

The storage battery plant consists of a set of 12 cells of Chloride accumulators in duplicate, Fig. 7. The 12 cells supply all the battery current for the operators' instruments, line, supervisory and pilot lamps and all the subscribers' instruments. The battery rack is constructed of architectural iron and is strong and well braced. The shelves are heavy slate slabs.

The telephones in these systems are of the International long-distance type central energy instruments, which are well known in the telephone field as being among the most powerful, clear and distinct instruments in use. It would appear that this class of equipment practically opening the independent field in Canada will have a tendency to bring a large part of the work in this line to the United States.

The Armature Reaction of Alternators—IX.

BY C. F. GUILBERT.

NUMERICAL APPLICATIONS.

IN the preceding articles a general method was given for the predetermination of alternator load characteristics. To terminate the study, we will now show by several numerical examples the degree of exactitude that may be attained by the use of the method. Though the author has applied the method to a large number of machines he has personally tested, one of these cannot well be chosen as the subject of a numerical example in view of the fact that the data of the tests were not intended to be made public. We shall, therefore, select a machine of which the test data have been published. Such an example is offered in Prof. E. Arnolds's "Konstruckionstafeln fur Dynamobau," in a machine made by one of the best electrical manufacturing firms in the world—Brown, Boveri et Cie, of Baden, Switzerland.

The machine is one installed by the firm at Paderno, Italy, of 1,500 kv-amp capacity, and of which Prof. Arnold gives plans and cross-sections, test data and no-load and short-circuit characteristics. Before applying the method to this machine, we will give several examples of the predetermination of short-circuit characteristics, taking as subjects alternators at the Paris Exposition (an account of which by the writer appeared in these columns in the issue of January 19, 1901, and following), which appear to have undergone reliable tests.

The predetermination of the short-circuit characteristic no longer offers other than a relative interest, as has been shown in the course of these articles, the wattless characteristic being preferable. However, since the short-circuit characteristic is easy of determination, if we know the armature m.m.f. and the e.m.f. of self-induction due to magnetic leakage, it is not without interest if merely as a simple verification of the formula of the form of the m.m.f.

At present there is no rigorous formula for the determining of the e.m.f. armature leakage of an alternator, either in short circuit or under load. All of the formulas thus far published include numerical coefficients deduced from measurements made on existing machines of the same type. We will be content to obtain the ampere-turns necessary to create a flux corresponding to this leakage under the condition of short circuit by admitting that the flux varies from 10 to 20 per cent. of the no-load flux, according to the size of the machine and the number of armature ampere-turns. Our determination of the no-load characteristic will thus be simply a first approximation, but a sufficient one, as will be seen.

1,400-kv-amp Creusot Alternator.—The armature has two slots per pole and per phase, with 6 conductors per slot. The formula,

$$F_i = .588\ N_1 I_0 \frac{a}{b} \sin \frac{b}{a} \cdot \frac{\pi}{2}$$

gives, for $N_1 = 12$, $I_0 = 156\sqrt{2}$ and $a = b$, the value 1,550. Assume

that in short circuit, $\frac{r}{R_0} = .03$. The e.m.f. being taken as 15 per cent. for the toothed armature, this corresponds to 1,050 ampere-turns, whence the short-circuit e.m.f. will be 1,600 + 1,050 = 2,650 *a t.* The test gave 57 × 44.5 = 2,540 ampere-turns.

1,000-kv-amp Frankfort-Lahmeyer Alternator.—The armature has two slots per pole and per phase, with 6 conductors per slot. We have $N_1 = 12$, $I_0 = 115\sqrt{2}$, $a = b$, whence F_i = 1,550 ampere-turns. With a leakage e.m.f. of 15 per cent. (say 450 ampere-turns), we have 1,200 + 450 = 1,650 ampere-turns. The test gave 49 × 33.5 = 1,640 ampere-turns.

760-kv-amp Heyland Alternator.—The armature has two tunnels per pole and per phase, with three conductors per tunnel. We have $N_1 = 6$, $I_0 = 200\sqrt{2}$, $a = b$, whence F_i = 1,000 ampere-turns. Assuming for a tunnel armature a leakage of 20 per cent. (say 1,050 ampere-turns), we have 1,030 + 1,050 = 2,080 ampere-turns. The test showed 36 × 63.5 = 2,280 ampere-turns.

1,200-kv-amp Alternator of Société l'Eclairage Electrique.—The armature has two tunnels per pole and per phase, with five conductors per tunnel. We have $N_1 = 10$, $I_0 = 138\sqrt{2}$, $a = b$, whence F_i = 1,150 ampere-turns. With a leakage e.m.f. of 20 per cent. (650 ampere-turns) we have 1,200 + 650 = 1,850. The test gave 40 × 43.5 = 1,740.

1,760-kv-amp Brown, Boveri Alternator.—The armature has two tunnels per pole and per phase, with 6 conductors per tunnel. We have $N_1 = 12$, $I_0 = 170\sqrt{2}$, $a = b$, whence F_i = 1,700. With a leakage e.m.f. of 20 per cent. (1,300 ampere-turns) we have 1,750 + 1,300 = 3,050. The test gave 60 × 44.5 = 2,670.

860-kv-amp Routen Alternator.—The armature has a single tunnel per pole and per phase, with seven conductors per tunnel. We have $N_1 = 7$, $I_0 = 207\sqrt{2}$, $a = b$, whence F_i = 1,250. With a leakage of 20 per cent. (850 ampere-turns) we obtain 1,300 + 850 = 2,150. The test gave 34 × 69.5 = 2,360 ampere-turns.

2,600-kv-amp Siemens & Halske Alternator.—The armature has three slots per pole and per phase. $N_1 = 3$, $I_0 = 52\sqrt{2}$, $a = b$, whence F_i = 1,300. With a leakage coefficient of 15 per cent. (750 ampere-turns) we have 1,350 + 750 = 2,100. The test gave 1,900 ampere-turns.

1,375-kv-amp Oerlikon Alternator.—A single slot per pole and per phase and eleven conductors per slot. $N_1 = 11$, $I_0 = 14\sqrt{2}$, $a = b$, whence F_i = 1,450. With a leakage e.m.f. of 15 per cent. normal (600 ampere-turns) we have 1,500 + 600 = 2,100 ampere-turns. The test gave 33 × 53.5 ampere-turns.

800-kv-amp Fives-Lille Alternator.—Two slots per pole and per phase and 2.5 conductors per slot. $N_1 = 5$, $I_0 = 210\sqrt{2}$, $a = b$, whence F_i = 875. With a leakage coefficient of 15 per cent. (500 ampere-turns) we have 900 + 500 = 1,400 ampere-turns. The test gave 155 × 15 = 1,160 ampere-turns.

780-kv-amp Kolben Alternator.—One slot per pole and phase and six conductors per slot. $N_1 = 6$, $I_0 = 150\sqrt{2}$, $a = b$, whence F_i = 775. With a leakage e.m.f. of 15 per cent. (450 ampere-turns) we have 800 + 450 = 1,250 ampere-turns. The test gave 22.5 × 59.5 = 1,340 ampere-turns.

The relative errors are in general much less when we determine as exactly as possible the leakage coefficient instead of assuming it. In the following article the predetermination of a load characteristic will be taken up.

Rewards for Carefulness

The Pittsburg Railway Company distributed almost $30,000 to 2,400 men at Christmas, as promised six months ago by the company to motormen and conductors as a reward for carefulness in avoiding accidents during the six months ended November 30. About 80 per cent. of the motormen and conductors participate in the premium distributions. Some 300 of the 2,400 had small accident charges, which aggregated less than the amount of their premiums, and they get the difference. About eight premiums were wiped out by accident charges. Considering the number of cars (1,200) and the more than 500 miles of track operated, the company has not had many serious accidents this year. The money was paid by check, a special check being adopted for the purpose. With each check goes a premium certificate which many of the men will treasure more than the money, as it will at all times be a recommendation for employment elsewhere should the holder need it.

New Telephone Patents.

It must surely seem remarkable to the older telephone men to note the changes in switchboard jacks from the almost obsolete, individually-mounted spring jack through the various stages of hard rubber strip jacks, down to the present metal frame jack strips, with their extremely small spacing. The Patent Office issue of December 23 chronicles another step in advance in jack construction in a patent issued to W. E. McCormick, of Chicago, and assigned by him to the International Telephone Manufacturing Company. Mr. McCormick's invention is well shown in Fig. 1. In this figure *b* is a bent metal strip which is the foundation upon which the jack strip is built up. This strip is provided at its ends with suitable arrangements for securing the jack strip in the switchboard. Upon each side of the strip *b* is placed a piece of hard rubber. These have perforations to

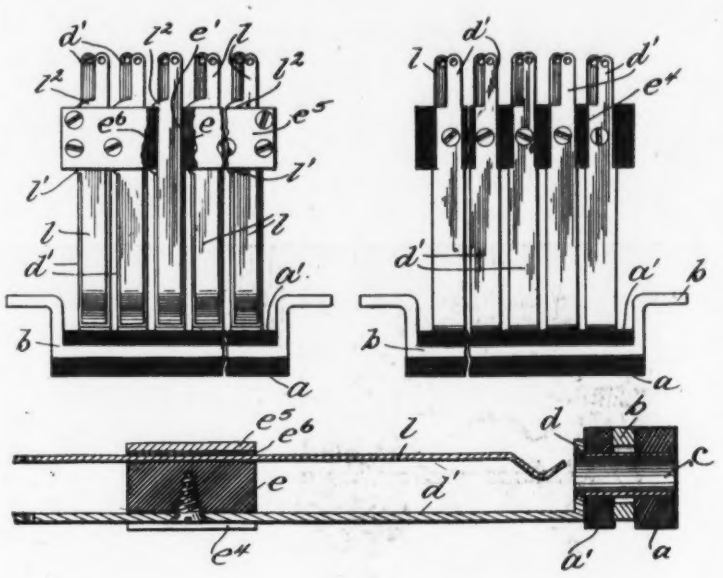


FIG. 1.—M'CORMICK JACK.

just admit the flared end jack thimbles *c*, while the strip *b* is so perforated as to clear the jack thimbles. The rear end of the jack thimble *c* is threaded, as is also the bent terminal strip d^1.

Now by screwing the thimbles into the terminal plates the whole front structure is securely bound together. The rear framing of the jack strip is a grooved hard rubber strip to which the terminal plates are attached by screws, and to which the jack springs are attached by the clamping plate e^5. In order to prevent any motion of the springs, the ears, l^1 l^2, are provided, which engage the rear rubber strip. This should form a very cheap and serviceable jack strip.

A second telephone patent of the same issue is that numbered 716,779, granted to A. B. Stetson, of Malden, Mass., and assigned to

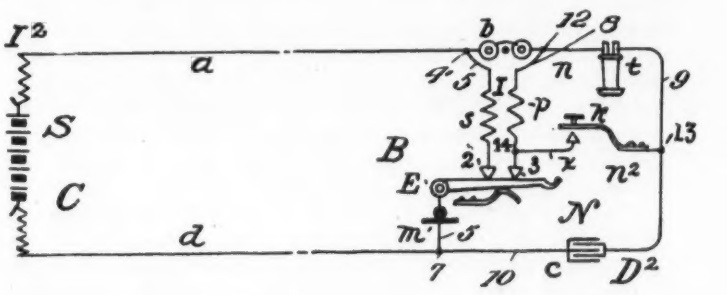


FIG. 2.—SUBSCRIBERS' STATION CIRCUITS.

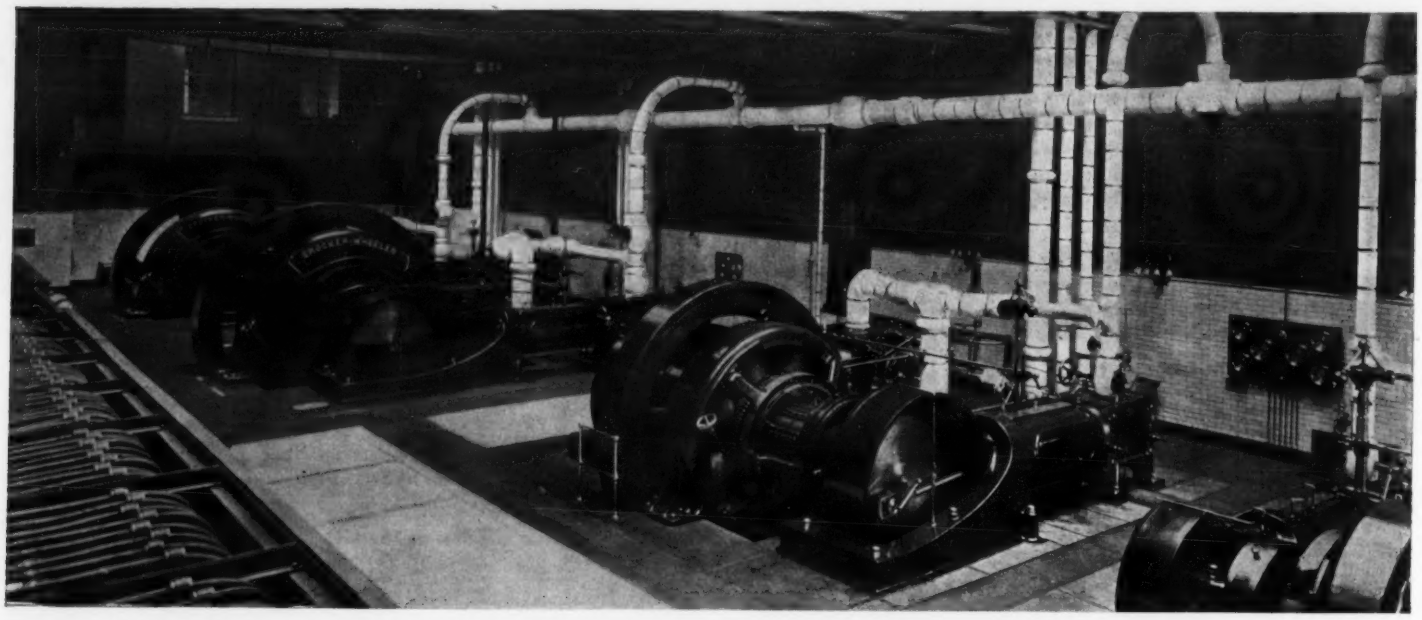
the American Telephone & Telegraph Company. The invention consists essentially in the application of the equivalent of the old secondary cut-out button of magneto days to the Bell Companys subscriber's station circuits. The operation of the device may be understood by reference to Fig. 2. When the transmitter, *m*, is disturbed, and as its resistance changes, the potential differences across its terminals varies correspondingly the quantity of charge in the condenser *c*. This charging and discharging of the condenser sets up

currents in the primary of the induction coil *p*, which in turn reacts upon the secondary *s* to send out upon the line toward the distant station the transformed electrical surgings. Now if a connection be established at *x k*, the condenser charge and discharge current will not pass through the induction coil primary, this being short circuited. Therefore the only extraneous tone existing will be that obtained from the transmitter through its direct effect upon the high resistance line circuit from the central office. It is also evident that the existence of the closed circuit, *xk*, will not affect the receiving circuit, as the induction coil primary is now in direct circuit wth the receiver.

Another telephone patent of the issue of December 23 was granted to Wayne C. Wright, of Texas. The patent specification purports to describe a new automatic telephone system. Although the writer finds that all the operations described can take place, and with the results specified, he fails utterly to see what utility there is in the invention, as he can conceive of no application for it in its present form.

Power Plant for New Government Printing Office, Washington.

Although but a part of the printing machinery has been installed at the new Government office at Washington, the power plant has been completed and is being used to operate the equipment in both of the buildings, as well as to furnish heat and light for the new



VIEW OF NEW GOVERNMENT PRINTING OFFICE PLANT, WASHINGTON, D. C.

structure. The latter occupies the entire side of one square in northeast Washington, reaching to a height of seven stories from the ground. Its floor space comprises nearly fifteen acres, being about two and a half times the area of the old establishment, and it is expected that nearly 4,000 persons will be employed in the various departments. Nearly 130 presses will be required for completing books and pamphlets, as well as in printing the Congressional Record. To operate the new plant it is calculated that nearly $4,000,000 will be expended annually, of which 75 per cent. will represent wages.

The electrical equipment is especially notable on account of its size and elaborate character. It consists of four units, all of Crocker-Wheeler make, two of them, of 600 kw capacity, being direct-connected to Allis engines. The other two units are of 300 and 150 kw capacity. The units are of the compound-wound type and are run at a speed of 100 revolutions per minute. Especial features of the machines are the internally flanged frame, giving a very smooth outside appearance and great rigidity. The brush rigging consists of a circular cast-iron ring held in place by supports bolted to the frame and holding the brush attachment. The brush holders themselves secure the brushes by means of a box, one side of which is held tightly against the brush. Four sets of copper leaves carry the current from the brush box to the arm, and their position is such that the movement of the brush on the commutator is always radial. Hence there is no necessity of changing the seating after the brush is once worn to place. The spiral spring with the thumb screw attachment secures the proper brush tension, and the copper leaves, carrying all the current, relieve the spring of any such duty. In spite of the great capacity of the apparatus, its compactness is also a notable feature. The large air gap tends to reduce field distortion and consequent sparking under heavy loads. The units have been in operation for several months and, as usual, they run very quietly and without heating.

Foreign Commerce of the United States in 1902.

Information from the United States Treasury states that the figures of the foreign commerce of the United States during the 11 months ending with November, which have just been completed by the Treasury Bureau of Statistics, indicate a phenomenal activity among the manufacturers of the country, with exportations quite as large as could be expected in view of the crop shortage of 1901-2. The value of manufacturers' materials imported into the United States during the 11 months ending with November this year is $407,603,599, against $353,417,288 in the corresponding months of last year, and forms 46½ per cent. of the total imports, against 44 per cent. of the total imports in the corresponding months of last year. Manufacturers exported during the 11 months of 1902 amount to $377,635,961, against $362,392,181 in the corresponding months of last year, and forms 31.8 per cent. of the total, against 27.8 per cent. of the total exports in the same months of 1901. The total imports are 75 million dollars in excess of those for the corresponding months of last year, and of this increase of 75 millions, 54 millions was in the class "manufacturers' materials" and the remainder manufactures and luxuries, articles of food and animals, showing a reduction of ten millions as compared with the importations during the corresponding months of last year.

Nearly all of the great articles required for use in manufacturing, with the single exception of india rubber, show a marked increase in importations. Importations of raw silk, for example, amount to $40,905,393 in the 11 months of this year, against $35,411,000 in the corresponding period of 1901; hides and skins, $53,022,521, against $50,877,797 in the 11 months of last year; tin for use in manufacturing tin-plate, $19,532,807, against $17,415,302 in the corresponding months of last year. India rubber importations show a slight falling off, the total for 11 months being $22,568,786 this year, against $25,929,985 in the same months of last year.

The most striking increase in importations is in manufactures of iron and steel, which amount, for the 11 months, to $36,766,961 in value, against $18,267,677 in the corresponding months of last year, the value of the importations having thus more than doubled this year as compared with last year. Practically every item in the list of iron and steel manufactures shows a marked increase. The export figures of iron and steel manufactures show a reduction, the total exports for the 11 months being $90,136,024 this year, against

$94,091,967 in the same months of last year, and $119,604,848 in 11 months of 1900.

The total exportation of the 11 months falls 116 million dollars below that of the corresponding period of 1901. This reduction occurs in agricultural products, of which the exportations during the 11 months of this year fall 130 million dollars below those of last year, indicating that in the other great classes, especially manufactures, there is an increase. This reduction of 130 millions in agricultural exports is due in part to the increased home demand, in part to the loss of a part of the corn crop of last year, corn exportations having fallen from $49,501,374 in 11 months of 1901 to $6,745,151 in the corresponding months of this year. There is also a considerable reduction in the value of wheat exported, due to the fact that last year's exportations were exceptionally large.

	——Eleven months ending—— Nov., 1901.	Nov., 1902.
IMPORTS—		
Food and animals	$203,448,487	$193,133,017
Crude manufacturers' materials	274,356,147	318,110,083
Manufacturers' materials, partly manufactured.	79,061,141	89,493,516
Manufactured articles	126,055,692	149,611,848
Luxuries and articles of voluntary use	117,504,764	124,617,093
Total imports	$800,426,231	$874,965,557
DOMESTIC EXPORTS—		
Agricultural products	$845,678,850	$715,771,314
Manufactures	362,392,181	377,635,961
Products of the mines	37,614,960	33,207,024
Products of the forest	46,761,217	48,261,040
Products of the fisheries	6,314,222	7,863,430
Miscellaneous articles	3,999,105	4,638,695
Total domestic	$1,302,760,535	$1,187,377,464
Foreign exports	25,425,596	25,332,599
Total exports	$1,328,186,131	$1,212,710,063

The Engineering of P. R. R. Tunnel.

The Pennsylvania Company has completed arrangements for the engineering of the New York tunnel, which will be carried on independently of the company's regular engineering department by a commission. While the tunnel and the terminal facilities will be devoted to the use of the Pennsylvania system, the work of construction will be carried on by the Pennsylvania, New York & Long Island Railroad Company, an auxiliary organization formed explicity to construct, own and operate this property. The actual accomplishment of this project, however, has been subdivided under three heads, and will be entrusted to three separate organizations, which in a measure will be distinct and independent, but at the same time will work entirely in harmony. These are the commission above referred to, composed of six prominent engineering experts, the engineering department and the architectural department.

The commission will consist of the following members: Colonel C. W. Raymond, United States engineer in charge of New York harbor work, who will be chairman; Charles M. Jacobs, chief engineer of the North River section of the tunnel, which extends from west of the Bergen Hill in New Jersey to the terminal station at Ninth Avenue, in New York; Alfred Noble, chief engineer of the East River section, which will extend from Seventh Avenue, New York, to Long Island City; William H. Brown, chief engineer of the Pennsylvania Railroad system, who will be chief engineer of the terminals and track construction; Gustav Lindenthal, the present bridge commissioner of New York, who will act in a general advisory capacity, and George Gibbs, who will have charge of the traction, mechanical and electrical engineering. Mr. Gibbs is also electrical engineer of the Long Island Railroad Company, which is at present engaged in the electrification of its lines in conjunction with the Pennsylvania system, of which it is a part.

The engineering has been entrusted to Westinghouse, Church, Kerr & Co., which will have charge of all engineering problems exclusive of the construction of the tunnel proper, and will act as engineers for the Pennsylvania Railroad Company, the Long Island Railroad Company and the architects in the working out of all problems involving civil, mechanical and electrical engineering. The architectural work has been assigned to McKim, Mead & White, who will have charge of all structural details involving the terminal station and accompanying structures of the New York terminal.

The engineering department has already completed plans for the power plant in Long Island City, which will be the first one to be installed, and this plant will be utilized in the construction work. There will be another electrical power plant in New Jersey, probably near the western terminal of the tunnel, but this will not be undertaken until the work on the tunnel has progressed considerably. For the present efforts will be directed toward completing the Long Island branch of the work, including the transformation of the Atlantic Avenue line of the Long Island Railroad Company into an electric system. This will extend from Flatbush Avenue to Jamaica, and will have a physical connection with the Rapid Transit Subway system, but it has not yet been determined whether the cars of the Long Island Railway will be operated through the subway or not.

CURRENT NEWS AND NOTES.

FRENCH TELEGRAPHS.—The revenue returns in France for November show that the receipts were 1,147,700f. in excess of the estimates and 7,397,900f. more than the amount received during the same period last year. The telegraph service, which for some months had shown a decrease, has this time increased by 63,600f.

A NEW PROMETHEUS.—A cable dispatch from Milan, Italy, of December 29, says: The *Secolo* says that Signor Pansa, an engineer of Cassino, has invented a machine which converts the sun's light and heat into an alternating electric current. He believes that by the use of this machine every one will soon be enabled to manufacture his own electric power, light and heat.

X-RAYS AND TUBERCULOSIS.—A cable dispatch from Berlin of December 27 says: Interesting experiments are being made in Prof. von Leyden's clinic with Roentgen rays, with the aid of which photographs are being made in order to discover first traces of tuberculosis. If the disease exists small knots are shown in the photographs. The new method is said to be an improvement over the old.

N. E. L. A. COMMITTEES.—The following appointments have been made by President Ferguson, of the National Electric Light Association, in the new departments which were created at the last convention: Reporter for wrinkle department, Mr. J. H. Perkins, Youngstown, O.; committee on lost and unaccounted for current, Mr. L. G. Van Ness, Lincoln, Neb.; reporter department of decorative lighting, Mr. A. S. Williams, New York Edison Co.; committee on theft of current, Mr. R. L. Elliot, Chicago Edison Co.; reporter department of office methods and accounting, Mr. W. M. Anthony, Chicago Edison Co.

DYNAMITE IN COAL.—Telegrams from Buffalo of December 27 state that a catastrophe was averted in the electric light plant at East Aurora, Erie County, by the timely discovery of dynamite in a consignment of bituminous coal that had been received at the plant from Pennsylvania. The coal supply of the plant has been short and some of the coal was being shovelled direct from the cars to the fires. The workmen on the car found a stick of dynamite and notified the fireman, who found several more sticks in his barrow of coal. In all, seven sticks of dynamite were found. It is not known whether or not the dynamite was placed in the coal at the mines or since the coal left the mines.

PUMPING ENGINE EFFICIENCY.—Tests of pumping engines recently installed by the Allis Company at St. Louis and Boston direct attention to the very high efficiency attained with engines designed for pumping duty. Both are triple-expansion engines, and that at St. Louis developed an average of 801.6 hp. on a boiler pressure of 126.7 lbs. The average consumption of dry steam was 10.676 pounds per hp.-hour, the thermal efficiency 21.003 per cent., and the mechanical efficiency 96.84 per cent. This result is the more remarkable from the low steam pressure, which is below the economical pressure for a triple-expansion engine. For comparison with other pumping engines, it may be said that the above performance corresponds to a duty of 179,454,255.

FANNING ISLAND CABLE STATION.—A cable dispatch from Honolulu says: The British Cable Company, owning the All Red Line from Vancouver to Australia via Fanning Island, has made an offer to James and Henry Bicknell, of Honolulu, to purchase their half interest in Fanning Island. "King" Grief owns the other half interest. James Bicknell will leave for San Francisco on the "Zealandia" and may close a bargain with the British company.

MESSENGERS IN JANUARY.—An unusual demand exists in New York always for messenger boys in the first two weeks in January. Some of the larger downtown banks call for the services of from ten to forty boys all day for ten to fourteen days in January, beginning with the 2d of the month, while at other times they employ none at all regularly except on call. This results, necessarily, in an increase in the force of boys at the downtown offices of the District Messenger Company, from which the boys are sent to those in need of them. To meet this demand the uptown offices of the messenger company are practically stripped of the sharpest and cleverest boys usually employed there, and the night boys have to work for several hours in the busiest part of the day. Some of the boys were so overworked this Christmas, or so overburdened with presents, they went on strike.

PREECE ON WIRELESS TELEGRAPHY.—A cable dispatch from London of December 23 says: Sir William Henry Preece, formerly president of the Institution of Civil Engineers and a well-known electrician, was interviewed to-day in regard to Marconi's latest experiments in ocean wireless telegraphy. Sir William was emphatic in declaring it to be his opinion that the wireless system would never become a serious competitor of the submarine cable. In the first place, he said, there was the want of reliability. It was possible to tap every wireless message and consequently there could be no privacy. Secondly, there was the low rate of speed of the wireless system as compared with the cables. Sir William expressed the opinion that wireless ocean telegraphy would never be practicable as an important means of communication because it could never stand comparison with the cables.

ELECTRIFYING ERIE CANAL.—It is stated that in a letter Governor Odell has received from former United States Senator Warner Miller, the latter says that the need of the improved canal to preserve the commerce of New York is conceded by all. The remedy must be one that can be made effective within two or three years. The ex-Senator says the solution is in the immediate completion of what is known as the nine-foot improvement and the adoption of electricity as the power to drive the barges through the waterway. "The 1,000-ton barge canal cannot be constructed in less than eight years," continues Mr. Miller, "and many persons competent to form an opinion believe it will take nearer twelve. In that time the danger to our commerce will have worked its evil consequences and a large part of trade will have been diverted through other channels to our rival ports, never to be recovered."

CURRENT FROM THE AIR.—We have been in receipt lately of documents relative to a scheme to get electricity in abundance from the upper air. Chicago is to be the scene of the first experiments and eight acres of land on the North side have been purchased for the erection of a plant. The scheme worked out by Albert G. Whitney is to project a wire cable 250 miles above the earth. He says that the atmosphere extends to a height of about seventeen miles. Above the atmosphere, Mr. Whitney says, the ethereal regions are reached, and at this place the force of gravitation is away from, instead of toward the earth. The projection of forty miles of cable, if Mr. Whitney's theories are correct, would cause the whole cable to recede from the earth, so that he could unwind any quantity of cable and the wire would maintain its rigidity. Mr. Whitney says that experiments have shown that the ethereal regions are surcharged with electricity and that this force will be transmitted to the earth's surface through the long wire cable. His patent specifications disclose his plan for achieving such results.

AN ELECTRIC AERIAL TORPEDO.—A telegram from Utica, N. Y., of December 27, says: Prof. Carl Myers, of Frankfort, to-day reopened his balloon farm for the manufacture of a number of war balloons for the Government and the building of several airships for various inventors who are to compete at the St. Louis Exposition for the $100,000 prize. He also announced to-day the completion of an "electric aerial torpedo," a machine which promises much in the solution of the problem of aerial navigation. The aerial torpedo flies like a thing of life. It is driven by two aluminum screw blades, which make 2,000 revolutions per minute. The blades are rotated by an electric motor which obtains its power from an ordinary incandescent lighting current of 110 volts. The movements are directed by two aeroplanes acting as rudders, moving the vessel up or down, right or left, in circles, spirals or cycloids, in all directions in mid-air as freely as a bird flies. All these evolutions are under the control of a distant operator, who moves an index over contact points on a dial switchboard, to which the vessel instantly responds.

GUARDING THE KAISER.—The following is from Berlin of December 13: Some of the German papers are printing remarkable stories concerning the precautions that are taken to ensure the safety of the Kaiser when he is traveling at night. The Kaiser takes no chances. The carriages which he now uses at night are equipped with a contrivance so unique as to be worthy of mention. It is an electric lamp as big and as dazzling as an arc light, fastened to the end of the carriage pole. Of course, the lamp, like the headlight of an engine, lights up the ground for 100 feet or more ahead, and enables the postillions or the driver to see in time any bomb or canister of explosives which may be lying in the roadway, placed there with the object of blowing the Imperial equipage into the air on being struck either by the horses' hoofs or by the wheels of the conveyance. Besides this the light is so dazzling that, moving quickly as it does, it would render it very difficult for any would-be regicide to take a good aim at the carriage from the road. Of course, the Emperor's horses have to be specially trained to stand the light, and this is no easy task, for although they are behind the light, yet their sensitive eyes cannot but be dazzled by the brilliancy of the illumination before them.

SUSPENDED ROAD FOR BERLIN.—It is proposed to construct for Berlin suburbs a hanging electric road of the type already described and illustrated in these pages. The "Schwebebahn" would begin at the station Gesundbrunnen, run through the Brunnenstrasse to the Rosenthaler Thor, and from there to the Alexander Platz station, Oranienburger Platz, Kottbuser Thor, Hermanns Platz, passing through the suburb Ricksdorf, and ending at the station of the belt line at the Hermanns Platz. The managers of the proposed "hanging" road say that their system has many advantages over the existing elevated lines; less building material will be needed in the erection of the superstructure, as the cars would be suspended from a structure and would depend on only one track; sharper curves would be possible, and even at the sharpest curves trains can run at a fast speed. The high tracks would not darken the streets as do ordinary superstructures of the elevated roads. The line as proposed would have a length of about six miles. Trains will consist of three motor cars with fifty seats. Later it is hoped to run trains consisting of six cars. The road would be able to carry 9,000 passengers in an hour. The cost of operating it would, it is claimed, be much less than other lines.

WANTING SUBMARINE BOATS.—It is stated from Washington that the Secretary of the Navy has received simultaneous requests from commercial bodies in New York, Boston, San Francisco and other ports asking for more submarine torpedo boats with which to defend those harbors. The similarity of the requests and the fact that all are made at the same time, has given rise to the opinion in the Navy Department that the lobby at work here has extended its operations by creating a local demand for submarines. A number of Senators, representing seacoast States, have received urgent requests to support large appropriations for submarine vessels, on the ground that they are badly needed for harbor defence. The Senate and House Committees have been cautious in favoring submarine boats, as their efficiency in war conditions is yet to be proved. So far as the defences of New York and San Francisco are concerned, naval experts say that submarine vessels are superfluous. Both harbors are provided with mines to prevent the entrance of an enemy's craft, and the fortifications are designed to make it impossible for the enemy to even approach the harbors. If reliance cannot be placed on the big coast defence guns and submarine mines, they think little would be accomplished by the use of submarine torpedo boats. The navy is giving them a fair trial, however, and if they prove serviceable no doubt more will be allowed by Congress.

NEW YORK ELECTRICAL SOCIETY will open the new year with an interesting meeting on January 7 at the American Institute, West Forty-fourth Street, to be devoted to important questions connected with fire insurance and electricity, such as high-potential lines, fuses, underwriters' rules, etc. Among those promised or expected to speak are Messrs. Kennelly, Sachs, Forsyth, Arthur Williams and others prominent in the art.

BALANCED-CIRCUIT INDUCTION COIL.—A patent issued December 23 to John P. Alexander describes an arrangement for the conversion of direct into alternating current by means of induction coils. The primary coil is so arranged with relation to the line conductors as to form a bridge across a divided and balanced circuit, in the branches of which balancing resistances and circuit-breakers are connected. By this means a current may be sent through the coil or through the united branches of the divided circuit without interrupting the flow of the supply current, while at the same time charging and discharging the primary coil so as to secure inductive reaction upon a secondary, and from this to other circuits or translating devices. The system is applicable to railway multiple control, telephone transmitting apparatus and other uses.

COMPENSATION FOR TRANSMISSION LINE INDUCTION DROP.—A patent issued December 23 to John F. Kelley describes a means of compensation for the induction drop on long alternating-current lines, and also for the *CR* drop on the same lines. An auxiliary generator of the inductor type is operated from the main generator shaft, with its armature in series with the latter. From the secondary of a transformer of which the primary is in series with the working circuit, current is passed to a rectifying commutator on the shaft of the auxiliary generator and thence to the field of the latter. The auxiliary generator is so constructed as to permit of adjustment of the relation between the stator and rotor. By a proper adjustment, the auxiliary generator sets up an e.m.f., one component of which is equal and opposite to the line e.m.f. due to the line inductance, thus neutralizing it; another component is in phase with the working e.m.f. and compensates for the *CR* drop, the field of the auxiliary generator increasing in strength with increase of main current output.

BREAKING ELECTRIC CURRENTS.—Three patents of the issue of December 23 relate to means for avoiding sparks upon the interruption of electric currents, one being granted to W. L. R. Emmet and the others to Robert H. Read. The Emmet patent covers a fuse which is kept in tension by springs; when the fuse blows the separated parts are instantly drawn by the springs through narrow enclosed passages, at the same time a current of air being passed to expel the gases. The two Read patents relate to a method of passing a current of air across the arcing points, which serves to remove the arc gases and to cool the contacts. The arcing points are hollow and confined within an air-tight chamber in communication with a source of compressed air which is put in communication with the chamber just before the electrodes part. The stream of air removes the arc gases, cools the contacts and stretches the arc until it breaks. The hollow of both electrodes communicate with the open air, and when in contact form an air-tight joint within the air chamber.

ELECTROLYTIC CHLORATE.—Mr. Richard Threlfall, of Birmingham, England, proposes an interesting method for the production of chlorates by electrolysis of solutions of the chlorids of the alkali metals. The method is based on the well-known fact that solutions of hypochlorous acid are less stable than those of its salts; and from this the conclusion is drawn that the course of electrolysis should be such as to maintain at all times in the electrolyte a certain proportion of free hypochlorous acid. To this end a certain disproportion is maintained between the anodic and cathodic reactions, by diverting about one-twentieth of the total current from the principal cathode to a supplemental cathode in a compartment distinct from the main cell, but having electrolytic connection therewith. The supplemental cathode may be contained in a porous cup immersed in the main body of the electrolyte, or it may be in a compartment of the cell separated in any convenient manner, as by a porous diaphragm, from the principal electrolyte. The concentration of the caustic formed in the supplemental compartment should be kept low by continual replacement. The reactions, as stated by the patentee, are based upon the assumption that an amount of free chlorine corresponding to the excess current at the anode reacts with hypochlorite existing in the bath to form hypochlorous acid and chloride; and that the hypochlorous acid so formed oxidizes spontaneously to chloric acid, and that the latter, by simple interchange with further quantities of hypochlorite, yields the chlorate of the alkali metal.

DE FOREST WIRELESS TELEGRAPH PATENTS.—Among the patents of December 16 were three issued to Dr. Lee DeForest and E. H. Smythe, covering the principle of the electrolytic anti-coherer or responder, which is employed by the DeForest Wireless Telegraph Company. The principle involved, first discovered by Neugschwender, is that when between two closely opposing electrodes of soft metal, as silver, moisture or some electrolyzable fluid is deposited, minute chains of metallic particles or bridges are torn off from the anode and built into conducting chains across the gap. When electric waves traverse these bridges, electrolysis suddenly occurs in the minute films of liquid lying between the links of these "chains," with explosive generation of gas, which suddenly ruptures the bridges, resulting in a large increase of resistance of the gap. Upon cessation of the waves the bridges reform under the electrostatic stress from the local battery and the normal conductivity of the receiver is instantly and automatically restored. But when water alone is the medium, the gap is soon rendered nonsensitive and inoperative. Too great an amount of metallic particles is torn off from the anode, the hydrogen gas accumulates among the chains, and a spark will cause an actual coherence with complete clogging of the gap. The patents referred to disclose means whereby the device is rendered constantly sensitive. In one form the electrodes are separated by from two to five-thousandth of an inch by an interposing medium consisting of a mixture of glycerine and lead oxide.

LETTERS TO THE EDITORS.

"The Converser."

To the Editors of Electrical World and Engineer:

SIRS: A good name is much wanted for the movable combined transmitter and receiver now so much used, which is connected to the telephone call box by cords. It has been called "the transmitter," "the receiver," "the hand combination," "the microtelephone," and various other barbarous names.

I would suggest: "The converser," as being the apparatus by means of which the user converses with his distant correspondent.

Government Telegraph Office, H. W. JENNEY,
MELBOURNE, AUSTRALIA. *Chief Electrician.*

Third Rail Operation.

To the Editors of Electrical World and Engineer:

Sirs.—I notice in a recent issue some reference to the difficulties met with on the elevated road in this city, on account of ice and snow on the "third rail." Why could not this third rail have been installed upside down, trough and all, the shoe making contact from below? It seems to me that such a disposition would effectually prevent the accumulation of snow and ice on the contact surface, and I do not see that there could be any insurmountable difficulty in supporting it in this way. WM. A. ANTHONY.

NEW YORK CITY.

The Valtellina Three-Phase Railway.

To the Editors of Electrical World and Engineer:

SIRS: Referring to certain criticisms in the article in your issue of November 8 on the Valtellina Railway, I beg to say that the Italian government without any hesitation accorded permission for the use of 3,000 volts on the trolley line where crossing highways, and the special commission appointed to inspect the line before it was opened to the public confirmed this permission. In view of this I cannot see reason for the assertion that the Ganz Company found in Italy many discouraging conditions, especially when its work was favored in every manner by the Rete Adriatica Railway Company.

I notice that in your first article on the Valtellina Railway you do

not mention the Societa Italiana per la Trazione Elettrica Sulle Ferrovia, which really assumed financial responsibility for the project, thus making the construction of the Valtellina Railway possible, and besides took over all the hydraulic and power house work—that is to say, the largest part with respect to the cost of the Valtellina Railway's electrical equipment. The Rete Adriatica Railway Company assumed responsibility for all of the general expenses, amounting to about one million, and all the risk in the case of an economical failure of the experiment, the responsibility of the Ganz Company and that of the Soc. It. per la Traz. Elett. being only technical.

PIETRO LANINO,
Formerly Chief Electrical Engineer Rete Adriatica Railway Company.
BOLOGNA, Italy.

DIGEST
OF
CURRENT ELECTRICAL LITERATURE.

DYNAMOS, MOTORS AND TRANSFORMERS.

Speed Regulation of Induction Motors.—OSNOS.—An illustrated article in which, after a brief critical discussion of the various methods proposed for the speed regulation of induction motors, he expresses his opinion that the use of a direct-current dynamo commutator is the only proper means for this purpose. If resistances are inserted in the secondary, their action is that, at constant primary voltage, the current is diminished in the secondary, without change of the phase difference; the ohmic voltage drop consumes energy; if, instead of this, a counter e.m.f. is introduced into the external circuit of the secondary, the same result is obtained without loss of energy. For a decrease of speed of the induction motor, an external e.m.f. is required which, like the ohmic voltage drop in series resistances, is opposite to the e.m.f. of slip; this e.m.f. must also have the same frequency, as the e.m.f. of slip. For an increase of speed above the normal, the external e.m.f. must have the same direction as the e.m.f. of speed. For generating such an artificial e.m.f., the direct-current dynamo commutator is the best means, as with its aid it is easy to get alternating current of any phase and frequency. As by this means it is possible to adjust the phase of the secondary voltage, one is enabled not only to introduce the secondary e.m.f. required for speed regulation, but to supply also an e.m.f. of different phase to the secondary for compensation of the phase difference. The only difficulty is sparking at the commutator and this can be avoided. He first gives a general mathematical theory of this method of speed regulation and shows that the slip of such a motor equals the slip of the same motor under ordinary conditions (without speed regulation) minus the ratio of the secondary to the primary voltage multiplied by the cosine of the angle between both voltages. If the same set of brushes is used for speed regulation and compensation of the phase difference, the primary current must lead the e.m.f. in phase at speeds below synchronism and must lay at speeds above synchronism. He discusses in detail the Goerges series motor of this type and shows its weak points. For a good speed regulation

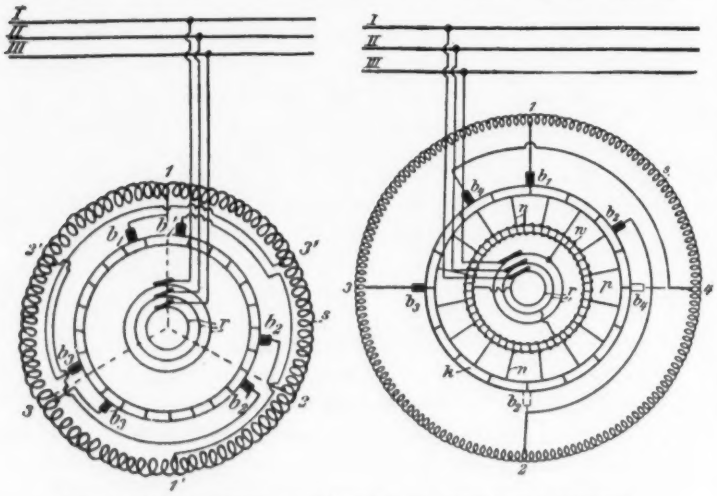


FIG. 1 AND 2.—SPEED REGULATION OF INDUCTION MOTORS.

it is necessary to transform economically the exciting current from the frequency of the network to the frequency of the slip; it is further necessary that the ratio of the primary to the secondary voltage and the phase difference between both be adjustable within wide limits. An arrangement for this purpose is shown in Fig. 1, in which p represents the primary of a bipolar induction motor provided with a direct-current winding, w, and commutator, k, analogous to the armature of a rotary converter. On the commutator there are sliding four brushes, connected to four symmetrical points of the secondary, s. The frequency of the current between two brushes equal the frequency of slip, while its phase depends upon the position of the brushes and the voltage upon the distance between the brushes. The voltage is greatest if b_2 and b_4 are at the points in the figure in which they are not shown in solid black; if they are, however, at the

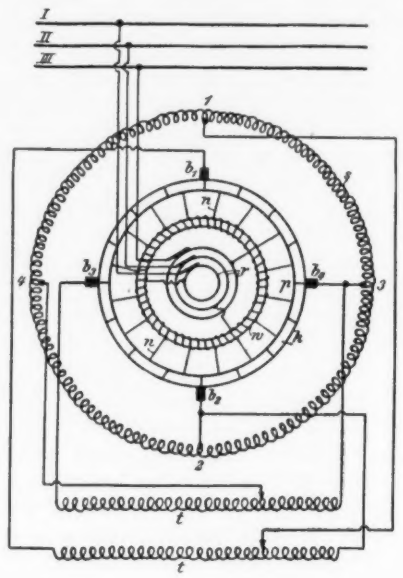


FIG. 3.—SPEED REGULATION OF INDUCTION MOTORS.

points shown in solid black, the voltage between the points 1 and 2, or 3 and 4, is reduced to the voltage between two segments. By changing the position of the brushes on the commutator, or by changing the connections between them, it is possible to vary the value and the phase of the voltage between the brushes within wide limits. This device differs from that for pure compensation of the phase difference in so far as the total secondary current in this case flows through the commutator; this disadvantage cannot be avoided. If the connections between the three symmetrical points, 1^1 2^1 3^1, shown in Fig. 2, are provided, the current taken all along the circumference of the commutator is uniform for any position of the brushes. The greater the number of poles, the greater is the difficulty of obtaining an exact speed regulation by the shifting of the brushes alone. It is, however, possible to use, as in Fig. 3, transformers t with a variable ratio of e.m.fs. He finally makes some remarks on means of avoiding sparks and says that these machines may also be used as frequency changers.—*Elek. Zeit.*, December 11.

REFERENCES.

Commutation.—MAWDSLEY.—An illustrated article on obtaining good commutation in direct-current dynamos. Hobart proposes to keep the reactance voltage of the coil undergoing commutation as low as possible. The writer describes special pole constructions that he calls "equalizing poles," for neutralizing the evil effects of the cross-magnetizing power of the armature. He claims that by this means sparkless commutation can be obtained even with a large

number of armature ampere-turns and high reactance voltage.—Lond. *Elec. Rev.*, December 5.

Paralleling of Alternators.—CRAMER.—An article illustrated by diagrams on the use of incandescent lamps as indicators for connecting alternators in parallel.—*Elek. Anz.*, November 30.

Specification for Dynamos and Rotary Converters.—HOBART.—An article in which he gives printed specification forms prepared by him for use in designing direct-current commutating machinery; they are of the kind used by most manufacturers for recording the constants of machines. The details of these blanks are briefly discussed. —Lond. *Elec. Rev.*, December 5, 12.

LIGHTS AND LIGHTING.

Electric Conduction in Electrolytic Incandescent Bodies.—GRADENWITZ.—An article on the nature of the electric conduction in the filament of the Nernst lamp. The Nernst lamp may be operated successfully for many hundreds of hours with direct current; if electrolysis really takes place, there must be another process which annihilates the action of electrolysis. Bose, in studying this problem, assumes that the oxygen anion is the principal agent; the oxygen liberated at the anode diffuses back to the cathode and oxidizes the pure metal which had been formed there. Some experiments of Bose, made in the vacuum, are described. The pure metal which is reduced at the cathode is not entirely oxidized back, there are fine threads of pure metal growing over from the cathode to the anode. A filament burning in the vacuum represents a system of an electrolytic conductor in shunt with a metallic conductor, with the exception of the neighborhood of the anode, where there is pure electrolytic conduction. The experiments explain some facts known to the manufacturers of the Nernst lamp. The life of a filament is greatly diminished by repeatedly changing the poles, on account of the partial reduction of the oxide and the internal tensions thereby produced. The filament gives less illumination at those parts when the metal is reduced, on account of the increased conductivity; a decrease of the efficiency results therefrom; as in direct-current lamps, a partial reduction of the filament takes place, they have a lower efficiency than alternating-current lamps.—*Elek. Anz.*, November 20.

POWER.

Refuse Destructor and Electric Plant.—An illustrated description of the Cleckheaton works. The refuse destructor is of the Meldrum regenerative "Simplex" type with two furnaces; the capacity is 20 tons of ashpit refuse per day of 24 hours and an evaporation (in conjunction with Lancashire boilers) of 1 pound of water with 1 pound of refuse is anticipated. There are three 150-kw, 460 to 500-volt, direct-current dynamos, and a battery of 270 cells. The three-wire system is used. The present load is entirely lighting, but traction will be added next year.—Lond. *Elec. Rev.*, December 12.

Governors for Engine-Driving Alternators.—PARKINSON.—An article on engine governors for parallel operation of alternators. He says that a suitable governor should either be very far removed from isochronous, having say 6 to 7 per cent. drop, or when sudden changes of load occur, the governor may have a smaller drop, say 3 to 4 per cent., but must not be too quick in action; this effect can be obtained by providing a spring governor with a powerful dashpot, or by using a dead-weight governor with considerable inertia in its moving parts.—Lond. *Elec. Rev.*, December 5.

REFERENCES.

French Water Power Plant.—LOPPE.—The first parts of an illustrated description of the plant of Vonvry. The capacity is 2,000 hp and the electrical energy generated is used for supplying a station in the neighborhood at times of heavy loads. The hydraulic installation is described in detail.—*L'Eclairage Elec.*, December 6, 13.

Steering Gear.—A very well illustrated description of an electric steering gear for a British yacht.—Lond. *Elec.*, December 12.

TRACTION.

Paris.—DURAND.—An illustrated description of the Nogentais traction system which supplies a part of the eastern suburbs. It is of interest on account of the different varieties of traction which are employed. From the city end, accumulator traction is used for a short distance, then comes an underground conduit which leads to the Vincennes Gate. From this point commences the suburban system which uses the trolley for the different branches. To carry out this arrangement, two types of cars are used; the first of these is equipped for accumulator, conduit and trolley, and takes passengers from the city terminus to the suburban points. The second type of car uses the trolley system alone, starting from the Vincennes Gate, where it connects with the eastern terminus of the Metropolitan and circulating through the suburbs.—*Elec. Rev.*, December 13.

Single-Phase Railways.—GEIPEL AND LANZE.—A communication referring to a recent remark of Swinburne, who had pointed out the particular suitability of single-phase alternating currents for working long railways and had suggested using for speed regulation, speed-reducing gear on the cataract system. The writers say that this method is well known to mechanical engineers and has been tried for motor cars and other purposes, but without success. They call attention to the Ward Leonard system of varying the speed electrically.—Lond *Eng'ing*, December 12.

REFERENCES.

Freight and Express on Electric Railways.—ADAMS.—An article in which he says that there are now cogent reasons for the extension of electric railway business to include the transportation of local freight and express matter. Express matter carried on interurban lines may be readily transferred to the local cars in any of the connected cities, and the necessity of wagon collection and delivery thus largely avoided. Statistical data on the development in Massachusetts are given.—*St. R'y Rev.*, December.

London.—A map, with a short description, showing the underground electric railways in operation, in the course of construction, in the course of change from steam to electric power, and before Parliament in London and the suburbs.—Lond. *Elec.*, December 12.

Western Ohio Railway.—TELL.—An illustrated article on the engineering features of this railway. The company operates at present 47 miles of road and has under construction 64 miles more. Three-phase currents are used for transmission to converter sub-stations.—*St. R'y Rev.*, December.

INSTALLATIONS, SYSTEMS AND APPLIANCES.

REFERENCES.

British Central Station.—An illustrated description of the new electric lighting plant of the town of Ross. The two-wire system is used at 230 volts. There are two 40-kw dynamos and a battery of 130 cells, giving 390 ampere-hours at a normal discharge capacity of 160 amperes per one hour.—Lond. *Elec. Eng.*, December 5.

Steamship Installation.—RICHARD.—The first part of a well-illustrated description of the electric installation of the steamship *Kronprinz Wilhelm.*—*L'Eclairage Elec.*, December 13.

Isolated Plant.—LAFFARGUE.—An illustrated article on an electric lighting plant in a cottage. A small oil engine drives the generator. There is an electric automobile which is used during the day for driving and in the evening as a reserve station to give current for lighting and various other applications.—*La Nature*, December 13.

Charging for Electrical Energy.—LAURIOL.—An article on tariffs for electrical energy. He speaks in favor of the use of the two-tariff meter, different rates being charged at different hours. This system is said to be equally in favor of the central station and of the consumer.—*L'Eclairage Elec.*, December 6.

ELECTRO-PHYSICS AND MAGNETISM.

Electric Origin of Molecular Attraction.—SUTHERLAND.—A paper in which he makes an attempt to reduce molecular action to the electron theory. He starts with the conception of a neutral gaseous molecule, containing a positive and a negative electron. Such a molecule will have poles like a magnet, and will exert upon a similar molecule an attractive or a repulsive action according to whether unlike or like poles are nearest. But an attraction tends to increase itself, and a repulsion tends to diminish itself, and so it comes about that on the whole there is more attraction than repulsion. Like magnets, the molecules attract each other with a force varying inversely as the fourth power of the distance. He shows that a strong contrast is shown to the law of gravitation, and the first condition of the electron theory is satisfied, by the fact that molecular mass does not enter into the expression for molecular attraction. It may be considered that the two electrons of a molecule like Na Cl, when giving the line spectrum of sodium, revolve round one another in a circle of such size that centrifugal force and electric attraction are in equilibrium. They revolve perhaps entirely within the sodium atom. —*Phil. Mag.*, December; abstracted in Lond. *Elec.*, December 12.

Electric Properties of Thin Metallic Films.—PATTERSON.—An account of some experiments which he has made with a view towards elucidating the problem of conduction in metals. He deposited the films in vacuum by the cathode discharge and found that the resistivity of such films is several times greater than that of the metal from which they are deposited. The specific resistance of platinum films which have been subjected to the same treatment remains constant above a thickness of about 0.000,000,7 cm. Below this thickness the increase of specific resistance with decrease in the thickness, is very rapid. Heat diminishes the resistance of both silver and platinum films, and the thinner the film, the greater the decrease.—*Phil. Mag.*, December; abstracted in Lond. *Elec.*, December 12.

Magneto-Optics of Liquid Hydrogen.—HARMS.—An account of experiments made with liquid oxygen concerning the relation between susceptibility and magnetic rotation of the plane of polarization. The angle of rotation in liquid oxygen is about one-fifth of that in liquid carbon bisulphide, and about 2,000 times that produced in the gas at atmospheric pressure. The author gives a corrected table of rotations and susceptibilities for a number of solids, gases and liquids, but fails to discover any regular relation between both properties.—*Phys. Zeit.*, December 1; abstracted in Lond. *Elec.*, December 12.

REFERENCES.

Thermo-Cells.—HORSTMANN.—An article on the efficiency of thermo-cells. An efficiency of 2 to 3 per cent. is thought to be the maximum that can be attained in practice.—*Elek. Anz.*, November 9.

Induction Coils.—ARMAZNAT.—A long mathematical article on the theory of induction coils.—*L'Eclairage Elec.*, November 15.

ELECTRO-CHEMISTRY AND BATTERIES.

Sodium Chloride in Electrolytic Caustic Alkali.—TOWNSEND.—An account of an experimental investigation concerning the movement of undecomposed sodium chloride into the caustic compartment. Of the several general types of cell, one only is capable of yielding a caustic solution absolutely free from dissolved chloride; that is the cell using a "stationary septum of mercury which is pervious to metallic sodium, but not to water or compounds in solution therein"; the provision of means which should entail neither undue complications of parts nor too great expenditure of energy for producing a sufficiently rapid transfer of the dissolved alkali metal, would make this cell the ideal one for the production of pure caustic solutions. In "gravity cells," if the flow of the liquid be rapid, assuming that the maximum permissible current density is employed, the current efficiency will be high, but the cathode lye will be low in caustic and high in salt. For the withdrawal of the products and the prevention of secondary reactions, a certain minimum rate of flow is essential, and this rate of flow is, in the cell constructions which have so far been proposed, too high to admit of thoroughly satisfactory concentrations of caustic. The diaphragm in a caustic cell is said to be essentially a device for controlling and equalizing the forward movement of the electrolyte and for retarding the backward movement of the products of electrolysis, and thereby permitting the establishment of a new and lower minimum flow for their removal. It is in no sense to be considered as a septum capable of permitting the passage of the electric current, but as preventing the diffusion and recombination of the products in stationary bodies of the electrolyte. The results of some experiments with a diaphragm cell are given in diagrams. For a solution containing one gram molecule of salt per nine of water the caustic attains approximately the supposed theoretical maximum, and the undecomposed salt is present nearly to saturation of the caustic. There is apparently a strong concentration of effect, inasmuch as the sum of the salt found and the salt equivalent of the caustic is far in excess of the saturation point for aqueous solutions of salt. The results of tests with more dilute solutions are also given.—*Electrochem. Ind.*, December.

Electrolytic Alkali.—An official communication from the Electrochemical Works at Bittefeld, Germany, to the effect that Kershaw's statement, that the Aussig bell process is being used at one of the Bitterfeld works, is wrong.—Lond. *Elec.*, December 5.

Determining the Best Conditions in Storage Battery Practice.—HERING.—An article, illustrated with diagrams, describing a method for calculating by means of curves, the conditions under which the best results are obtained in storage battery construction or operation; such calculations are difficult to make in any other way, even if it is at all possible. As an illustration of a simple case, the cost of a cell of a given capacity will increase at a certain rate with an increase of the weight of the plates; the life in number of discharges which it will stand, will also increase with the weight of the plates, but at a different rate; for a very light battery the first cost will be least, but the number of possible discharges will also be least, thus increasing the cost due to renewals; while for a very heavy battery the original cost will be much greater, but the number of possible discharges will increase also, thus reducing the cost of renewals; the result of this is, that at a certain weight this total cost per kw-hour capacity per discharge, including both the original cost and the cost of renewals, will be least, and this is the point which shows the best weight which the plates should have, so that the total cost will be the least. This is one of the illustrations which he gives; in the other illustrations he shows how to find the weight of plates at which the total mileage of an automobile battery per discharge of its life, will be greatest; also how to find out at what weight of plates the cost of the automobile battery per mile of total mileage will be least, or when the total mileage per dollar of battery will be greatest; or at how many discharges the average cost per kw-hour of useful energy delivered will be least. These are given only as illustrations, the article giving the general rules for making such calculations. In general, the data from which such calculations are to be made are given in the form of two curves having the same abscissa but different ordinates, and from this a third curve, with the same abscissa and the final desired ordinate, is calculated; if then there is a maximum or minimum value, this final curve will show it, and will show at what point this will be found. The method is not limited in its application to storage batteries, and it may also be used in many other cases, and enables one to determine the most economical conditions, which determinations would be extremely difficult to make, if at all possible, in any other way. The method is quite simple and rapid.—*Electrochem. Ind.*, December.

Conductivity of Nickel Oxides.—MARSH.—An article describing some experiments showing that nickel peroxide should not be termed a non-conductor, even from a practical standpoint, but should be classed with the conductors. He does not think that the flake graphite with which Edison mixes the nickel peroxide is necessary to increase the conductivity of the active mass, especially when the compound is properly prepared, yet he thinks that it prevents the peroxide from falling out of the perforated grid.—*Electrochem. Ind.*, December.

Artificial Diamonds.—LUDWIG.—An account of experiments on the transformation of carbon into diamond. He claims that under great pressure in the atmosphere of hydrogen carbon in contact with iron forms the diamond, and that carbon fused in the electric arc in the absence of iron, under the same conditions of pressure, is likewise converted into diamond. Pressures as high as 3,100 atmospheres were used; when a spiral of iron wire was embedded in powdered retort carbon, and heated by an electric current in a highly compressed atmosphere of hydrogen. Careful examination showed that on some of the pieces of carbon were brilliant, minute crystals, possessing the hardness, specific gravity, and refraction of the diamond. To produce diamonds without the use of iron, it was found necessary to use much higher temperatures and actually fuse the carbon under very high pressure, when it was found to be a non-conductor, and hence was considered to be the molten diamond; spherical masses of the size of peas were obtained. It is the intention of the author to develop the process for the commercial manufacture of diamonds.—*Chem. Zeit.*, v. 25, p. 979; abstracted in *Am. Jour. Sc.*, December.

REFERENCES.

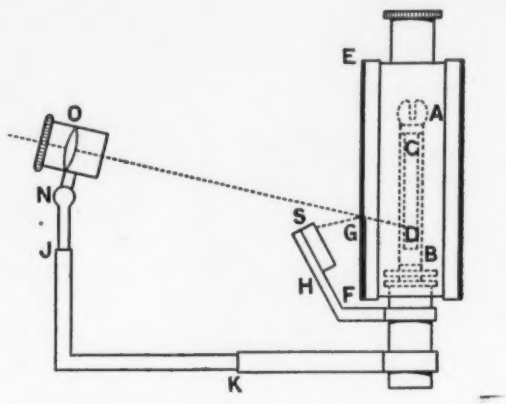
Electrometallurgy.—BEADLE.—In a continuation of his serial on electrometallurgical problems he discusses the production of gold and silver.—Lond. *Elec. Rev.*, November 14.

Organic Chemistry.—Several papers on the application of electrochemical methods to special subjects of organic chemistry, by Loeb, in *Zeit. f. Elektrochemie*, October 2; by Elbs and Brand, Elbs and Wohlfahrt, and Klappert, in *Zeit. f. Elektrochemie*, October 9, by Escherich and Moest, in *Zeit. f. Elektrochemie*, November 6.

Laboratory for Electrolytic Analysis.—RICHARD.—The first part of an illustrated description of the laboratory for electrolytic analysis of the Electrochemical Institute of Nancy.—*L'Eclairage Elec.*, December 13.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Electroscope Scale.—ELSTER AND GEITEL.—A description of a new scale for Exner's electroscope, which does away with the parallax between the scale and the leaves of the electroscope, without necessitating the presence of a scale at the leaves themselves. They do not engrave the scale on the wall of the case, but project it by means of a mirror into the plane of the leaves themselves. In the adjoining diagram *A B* is the carrier of the aluminum leaves, one of which, *C D*, is shown. The front glass wall, *E F*, is silvered from *G* to *F*. The scale, *S*, fastened to the holder, *H*, is as far in front of the glass case as the leaves are behind it. Thus an eye looking through *O*



ELECTROSCOPE SCALE.

sees the scales lying accurately in the plane of the nearest edges of the leaves, and no parallax between scale and leaves is possible. Telescope tubes at *J* and *K*, as well as a joint at *N*, permit a perfect adjustment of the eye-piece. The lens enables a more accurate reading to be made. The back wall of the case is of ground glass, and the lenses are adjusted vertically by means of levelling screws.—*Phys. Zeit.*, November 15; abstracted in Lond. *Elec.*, December 12.

REFERENCES.

Maximum Current Indicator.—MARXEN.—An illustrated description of a maximum current and short-circuit indicator of Hartmann & Braun. It registers the maximum currents at different time intervals, by the length of radial lines on a revolving disc.—*Elek. Zeit.*, December 11.

Measuring Insulation Faults.—MUELLENDORFF.—An article of a mathematical nature in which he describes a new method for measuring insulation faults in three (or more) wire installations.—*Elek. Zeit.*, December 11.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Pacific Cable Speed.—A reprint of a question and answer asked and given in the British Parliament concerning the speeds obtained on the Vancouver-Fanning Island section of the new Pacific cable. In an editorial discussion it is pointed out how much the new heavy-weight cores are superior in point of relative speed to the older and lighter type of core. According to the old standards, which are based upon empirical constants derived from actual observed speeds upon the older cables, a cable of 3,458 nauts, such as the Vancouver-Fanning Island section of the Pacific, would not be expected to give a greater speed than 120×10^6 kr five-letter words per minute, or 600×10^6 kr letters per minute, with hand or plain automatic sending and simplex conditions. Working upon this basis, and taking the kr of the above-mentioned cable as 9.4×10^9, which is approximately its correct value at sea temperature, the speed would be 64 letters per minute, and for automatic curb simplex working—allowing 20 per cent. increase for curb, which is a very full allowance—say 77 letters per minute. The figures quoted in Chamberlain's answer in the House are 85 and 100 letters per minute respectively, or say, 30 per cent. faster in each case. This, of course, is not the first occasion by any means upon which these large cores have proved their superiority and exceeded expectations. Many heavy-cored cables are now in existence, and have demonstrated by their speeds of working that the old constants, as applied to them, may be regarded as obsolete, and that the rk factor, or resistance per microfarad, is a very important one in the designing of cable cores.—Lond. *Elec.*, December 12.

REFERENCE.

Electric Clock.—KAREIS.—An illustrated description of an electric clock devised by Morawetz. The main points are the electric pendulum and the minute contact apparatus.—*Zeit. f. Elek.*, November 9.

New Books.

LA TRACTION ELECTRIQUE PAR CONTRACTS SUPERFICIELS DU SYSTEME DIATTO. By Cr. Julius. Paris: Gauthier-Villars. 66 pages, 12 illustrations.

We Americans are so prone to the vice of recognizing the existence of those things only with which we are familiar that this little volume will be found to contain much that is news even to professional engineers. This is the land of the trolley, and where it has been driven out by violence we make a mighty noise over the success of slotted conduits. It is therefore almost a shock to realize that in Paris the surface-contact system, here cast into outer darkness, is in actual use to the extent of nearly fifty miles of track. The opinions of American engineers who have seen it seem to differ widely as to its applicability to American conditions, most of them being rather pessimistic. But the pavements of Paris are nearer the surface of the soil than those of New York, and this makes a difference.

To tell the truth, one must realize that in any traction system the roadbed is as important as the arrangement of the rails, although too often neglected. The success of the surface-contact system like that of our familiar third rail system depends very largely on what lies about and under the rails, and this is just as legitimate a part of those systems as is the conduit of its system. This last failed conspicuously so long as it was too cheaply constructed. A careful perusal of M. Julius' little monograph is well worth the while for any engineer who wises to get a proper perspective of the world's progress in electric traction.

ANLASSER UND REGLER FUR ELEKTRISCHE MOTOREN UND GENERATOREN. By Rudolf Krause. Berlin: Julius Springer. 92 pages, 97 illustrations. Price, 4 marks.

This is a very useful little monograph on starting and regulating rheostats, brought well up to date and full of practical information. The subject is one which has been rather neglected in the literature, and Herr Krause has done the profession a real service in getting together a large amount of useful and otherwise somewhat inaccessible information. He sets forth briefly but very effectively the general principles of the design and construction of such apparatus, and while to the specialist the treatment seems somewhat meagre; it is nevertheless far more complete than the size of the volume would indicate. To one who has grubbed through the journals in the attempt to find something more generalized than descriptions of recently patented apparatus it will be especially welcome. The illustrations are plentiful and to the point, and altogether the volume is one to be recommended to students and to those who have casual occasion to deal with the matters described. We wish that more such handbooks were available, treating special corners of engineering.

BOOKS RECEIVED.

LOCOMOTIVES, SIMPLE, COMPOUND AND ELECTRIC. Fourth edition, revised and enlarged. By H. C. Reagan. New York: John Wiley & Sons. 604 pages, 309 illustrations. Price, $2.50.

MOTOR CARS AND THE APPLICATION OF MECHANICAL POWER TO ROAD VEHICLES. By Rhys Jenkins. London: T. Fisher Unwin. New York: James Pott & Co. 371 pages, 100 illustrations. Price, $5.00.

Directory of Electrical Societies, Etc.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, Secretary, Ralph W. Pope, 95 Liberty Street, New York. Meetings: January 23d, 1903, "Telephone Exchanges"; February 27th, "Railway Train Lighting," Wm. L. Bliss, Lamar Lyndon and A. J. Farnsworth; March 27th, "High-Tension Lines," Ralph D. Mershon; April 24th, "Tendencies of Central Station Development," H. A. Lardner, Philippo Torchio and Peter Junkersfeld.

ASSOCIATION OF EDISON ILLUMINATING COMPANIES, Secretary, W. H. Johnson, Philadelphia, Pa.

CANADIAN ELECTRICAL ASSOCIATION, Secretary, C. H. Mortimer, Toronto, Ont. Next meeting, Toronto, Ont., 1903.

THE ELECTRICAL TRADES SOCIETY (Member National Electrical Trades Association), Secretary, A. P. Eckert, 39 Cortlandt Street, New York. Board of Directors meets every second Friday of each month.

ENGINE BUILDERS' ASSOCIATION, J. P. Ide, Springfield, Ill., Secretary.

INTERSTATE INDEPENDENT TELEPHONE ASSOCIATION, Secretary, E. M. Coleman, Louisville, Ky. Next meeting, Chicago, December 9, 10 and 11, 1902.

KENTUCKY INDEPENDENT TELEPHONE ASSOCIATION, Secretary, H. K. Cole, of Lancaster, Ky.

NATIONAL ELECTRICAL CONTRACTORS' ASSOCIATION OF THE UNITED STATES, Secretary, W. H. Morton, Utica, N. Y. Next meeting, Detroit, Mich., July 15, 1903.

NATIONAL ELECTRIC LIGHT ASSOCIATION, Secretary, James B. Cahoon, 136 Liberty Street, New York. Next meeting, Chicago, May, 1903.

NEW YORK ELECTRICAL SOCIETY, Secretary, G. H. Guy, 114 Liberty Street, New York.

SOUTHERN INDIANA TELEPHONE ASSOCIATION, Secretary, E. W. Pichardt, Huntingburg, Ind.

New Shops of the British Thomson-Houston Company.

At Rugby, England, the British Thomson-Houston Company has created and put in operation during the past year some of the finest works for heavy electrical manufacturing to be found on the other side of the Atlantic, equipped throughout with the latest and best tools and machines of American and other make. The works lie north of the London & Northwestern Railway Station, and adjoin the London & Midland Railway. They comprise some 25½ acres, of which about 10 acres are at present covered by roads and buildings. The total ground covered in square feet by buildings is 197,220, and the total floor space in square feet is 206,230. The works consist of fourteen substantial steel and brick buildings, and have been so planned that extensions can be readily added as required, and that without interfering with production. The arrangement of buildings and of machinery has been to avoid the material being carried backwards and forwards for the different operations, and as far as practicable to bring in the raw material from the warehouse direct at the first point in the evolutions of the finished product, passing it along from tool to tool in one direction to suit the various processes of machining, until it finally reaches the sections of the shops where it will be assembled, tested and erected. Standard gauge tracks are laid in the various buildings where the product is finished or stored, and are connected with the railway sidings, so that the products can be loaded directly on the trucks without rehandling.

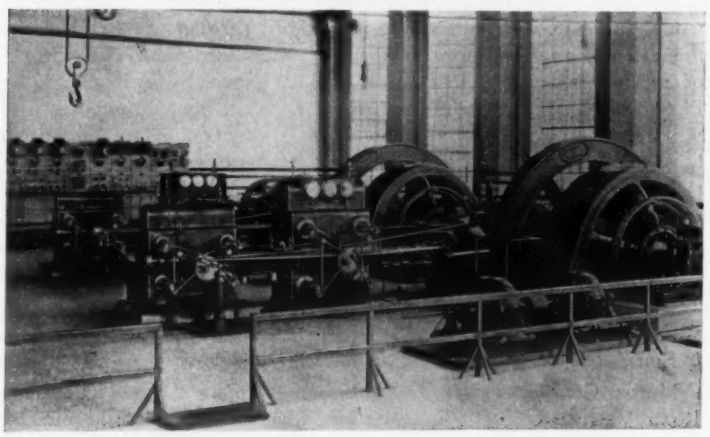


FIG. 1.—DIRECT-CONNECTED GENERATING SETS.

A notable feature of the plant is the power-house building, 110 x 110 feet. The foundations for the engines and boilers are of solid blue brickwork, built in cement, rising from the basement to the ground floor level to a height of 10 feet. The ground floor is composed of steel girders, strongly bolted together with tie-rods, and filled in with Portland cement concrete, to a thickness of 15 inches, with a top finish of mosaic. The walls of the engine house are artistically finished with glazed tile dado, with richly moulded capping and skirting; the window finishings are also richly moulded. The house contains three steam generators, two of which consist of a 200-kw. 550-volt continuous-current generator, coupled to horizontal tandem-compound Corliss-type engines. The engines, built by Cole, Marchant & Morley, Ltd., are each capable of giving a normal output of 320-ihp. when running at 120 r.p.m., with steam supplied at a pressure of 150 pounds per square inch at the engine stop valve, and with a vacuum of 25 inches of mercury in the exhaust pipe. The small set is a 100-kw. 550-volt continuous-current generator, coupled direct to a Browett Lindley horizontal tandem-compound engine running at 235 r.p.m. The condensing plant is of the Wheeler Condenser Company's "Admiralty" type, with 1,200 square feet of cooling surface, mounted on combined steam-driven air-circulating pumps.

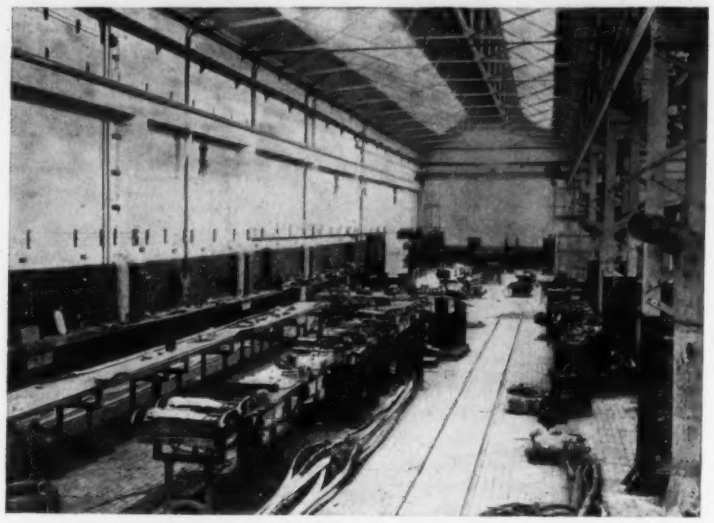


FIG. 2.—CONTROLLER DEPARTMENT.

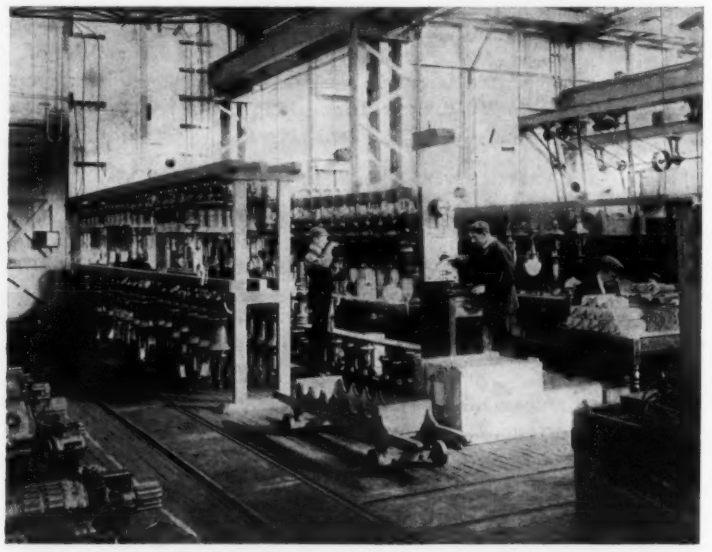


FIG. 3.—ARC LAMP TESTING DEPARTMENT.

The boiler house contains two Babcock & Wilcox units, each having a heating surface of 2,530 square feet, and fitted with superheaters capable of superheating the steam up to 100 degrees F. The working pressure is 160 pounds per square inch. The boilers are fitted with Vicars' stokers, driven through worm gearing by a 5-hp. motor running at 675 r.p.m. A third boiler is to be immediately installed. The economizer contains 320 pipes of the Clay Cross Company's make, the scraper gear being driven by an electric motor. The

chimney, seen for miles around, is of steel, lined throughout with brick, and 100 feet high.

The switchboard is designed for the control of the three generators and balancer set, and of the output for lighting and power. It is provided with a duplicate set of bus-bars, so that the circuit to the testing department may be run independently of the other circuits on either of the generators, this provision being made so that the other

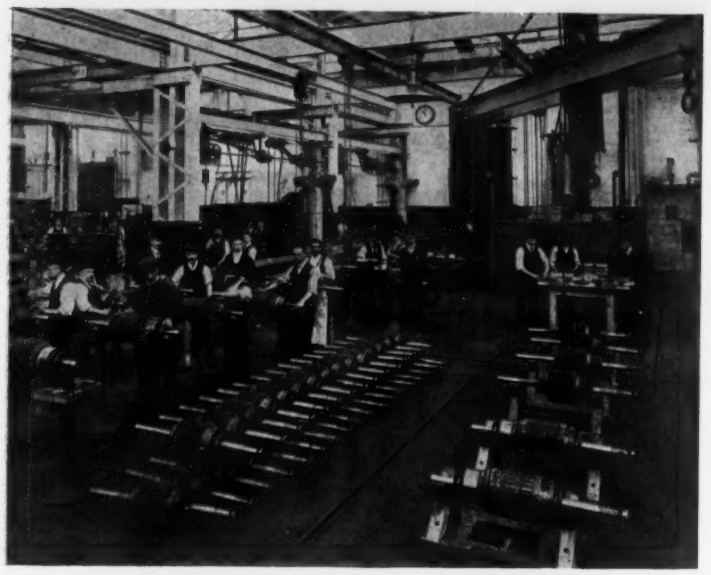


FIG. 4.—PART OF ARMATURE-WINDING DEPARTMENT.

circuits may be free from disturbance, due to short circuits in the testing department. The lighting circuits are run off the three-wire system and the circuit breakers protecting the two outer conductors are electrically interlocked so that it shall be impossible for the full voltage to be thrown on the lamps on either side in the event of a short on one side of the middle wire.

The office building has a floor space of 15,281 square feet, and consists of three floors. In the basement are located the purchasing, pub-

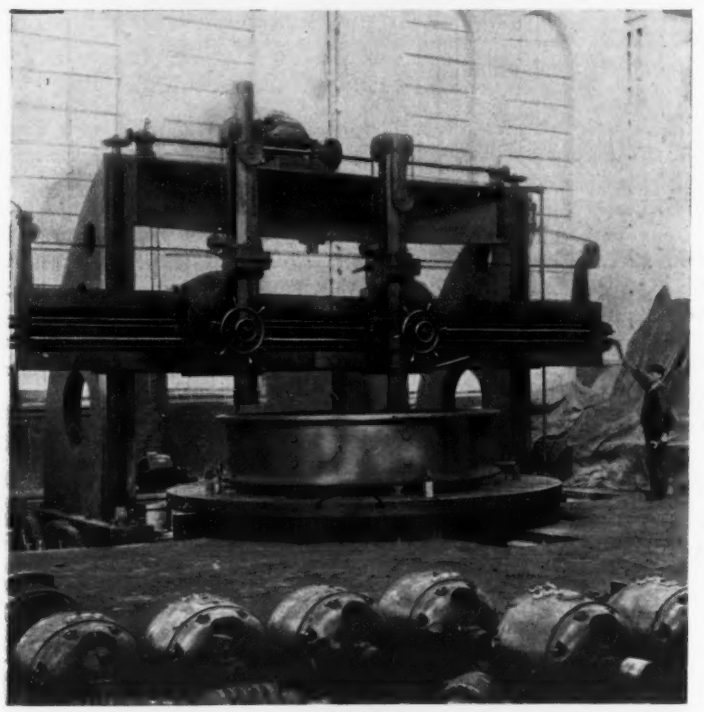


FIG. 5.—ELECTRICALLY-DRIVEN BORING MILL.

lication, typing, supply and mailing departments and the office in connection with the meter department. The ground floor is occupied by the inquiry office, commercial, works and engineering departments. On the floor above are situated the offices of the designing engineers, secretarial and accountings departments, data section and draughting room. In the small section above this floor, which forms the turret in front of the buildings, are situated the blue printing and photographic departments.

An Electric Express-Call System.

An electrical express call system has been invented by Robert J. Louis, President of the Louis Manufacturing Company, 141 West Twenty-fourth Street, New York, and is now being placed on the market; it is illustrated in Figs. 1 and 2 herewith.

The system consists of a tube or conduit running from the corridor or rotunda of the building to the top floor, and can be made either a part of or arranged alongside of the mail chute, run down the elevator shaft, or wherever most convenient, with an opening on each floor, or in each room if so desired, for the reception of a small disc, several of which, representing the different express companies, are provided for each room. These discs have the number of the room and the name of the company they represent inscribed on them. They are of slightly different sizes for the different express companies. To illustrate more particularly, suppose that tenant in room 1842, on the 18th floor of a sky-scraper, desires

FIG. 1.—EXPRESS-CALL SYSTEM.

to make a shipment by express company A. Selecting the disc representing express company A from the several that he is provided with, he places it in an aperture of the tube whence it descends to the ground floor, slowly rolls over a distributor and drops into the box of express company A. By an electrical device, as soon as the disc has dropped into the box, an electrical contact is made with the signal displayed on the outside of the building, which signal remains set until a passing driver, representing the company signalled, unlocks the box in the corridor, thus breaking the contact and allowing the signal to display again a blank surface. With the disc then in his possession, he sees at a glance from the number upon it, exactly what room he is expected to visit. Of course, it is understood that there may be a number of these discs from different rooms in the box at the same time, only the first one, however, turning the signal. In Fig. 1 are shown a section of the chute with the distributor underneath. The discs or checks vary in diameter from about 1 in. to 2 in. and are about 3/8 in. in thickness.

The means employed for the distribution of the checks to their proper boxes is interesting. When a check enters the distributor, it passes into a chute slightly lowered at one end from the horizontal. This chute is located above the individual boxes, and over each

box it is perforated with an opening of a size corresponding to the size of the check belonging to the box. In order to effect the proper selection, the smallest hole is nearest to the point of entrance, the second opening being the next larger in size, and so on in regular progression to the last, which is the largest size. When a check enters the tube, it rolls along at a slow speed until it meets with the opening of its own size, when it falls into its box.

The bottom of each individual box in the distributor consists of a metal plate fastened to the arm of a balance, the other arm constituting a contact point of an electrical circuit. When a disc falls into the box, its weight depresses the movable bottom and lifts the opposite arm, which closes a circuit having a relay connected in series; the relay in turn closing a circuit which operates the call signboard by means of a solenoid in a manner to be presently described.

The call indicator (Fig. 2) has two faces and is designed to be placed on the front of a building at right angles with the wall, thus enabling the express-call driver to see it coming from either direction. Each signboard consists of an oblong box of square section, two opposite sides being blank, the other two containing the name of an express company. The sides containing the letters are of ground

FIG. 2.—EXPRESS CALL SYSTEM.

glass and are illuminated at night by two lamps placed within the tube, the opaque letters standing out against the illuminated background. By means of a switch, these lights are turned on after dark.

Each signboard is pivoted at either end. At one end are located two solenoids, the cores of which are connected to a chain gear for the purpose of turning the signboard ¼ inch of a revolution. When the circuit is closed by the relay, one of the solenoids is energized and turns the signal so as to display the sign, and when the call driver opens the box and removes the checks, the other solenoid is thrown in circuit and turns the signal back to the blank position.

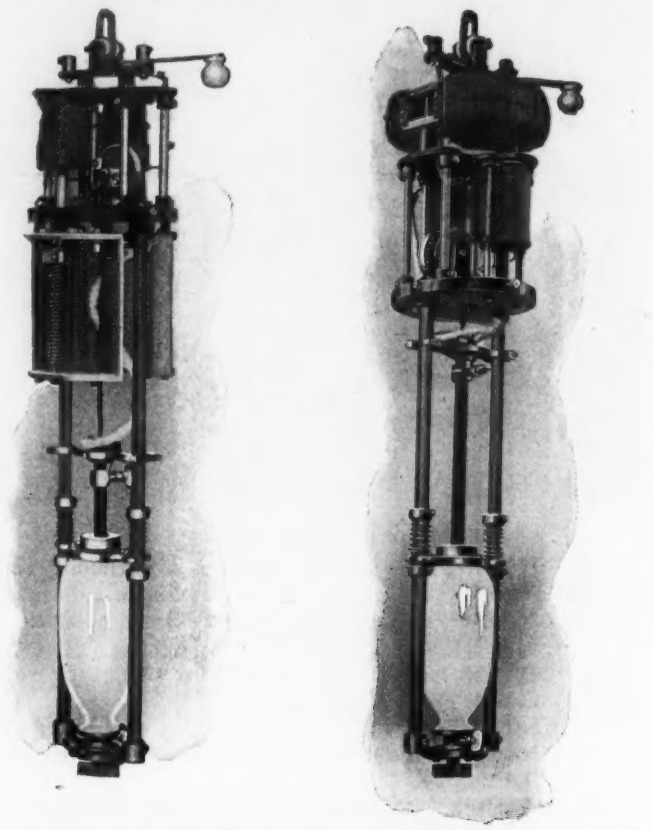
Small boxes like that shown in Fig. 1 between the section of chute and the distributing box are connected with the chute at each floor of the building. Each one contains a slot at one side into which the checks are inserted. The check drops through the side and into the chute.

Among the many advantages offered by this system are absolute accuracy, promptness and safety, and all of these features are particularly emphasized by the company. They will be duly and fully recognized and appreciated by express shippers, especially in tall loft and office buildings.

Sterling Arc Lamps.

The Stanley Electric Manufacturing Company has recently added to its products the Sterling arc lamps. The lamps are designed for operation in multiple on constant potential circuits and are made in the following types: Direct current, 100-125 volts; direct current, 200-250 volts; and alternating current, 100-125 volts. These three lamps are designed upon the same lines, so that interchangeability of mechanism is obtained to an unusual degree

Two series solenoids act upon a U-shaped core, which lifts the



FIGS. 1 AND 2.—DIRECT-CURRENT AND ALTERNATING-CURRENT LAMPS, WITH CASINGS REMOVED.

clutch and separates the carbon when current flows through them. In the direct-current type these solenoids are in the top of the lamp and the rheostat, consisting of easily-removable spirals of high grade resistance wire, is placed in the lower half of the lamp, separated from the working mechanism by the base-plate, as shown in Fig. 1. In the alternating-current lamp, the reactive coil is placed in the same compartment as the series solenoids, and is located above them, as shown in Fig. 2.

The frame and working parts are not in circuit on either side; therefore much trouble due to pitting of dash pots and working joints

FIG. 3.—RHEOSTAT.

FIG. 4.—REACTIVE COIL.

is avoided. Both upper and lower carbon holders are provided with simple thumb screws and make reliable connections with the carbons. The gas check is so constructed that the wearing parts next the carbons, which are made of hard-pressed asbestos washers, may be easily renewed.

In the direct-current lamp the rheostat, shown in Fig. 3, may be repaired by removing the frame from the lamp. This is done by

loosening two screws and taking out one or more sections or coils. In the alternating-current lamp, the reactive coil may be removed by taking out two screws and a pair of clamps. The reactive coil, shown in Fig. 4, is wound in sections and the terminals of two adjacent coils are soldered together. By unsoldering these terminals and slipping the sections around to the slot in the iron core, any section may be removed and replaced without great difficulty.

The outer globe is firmly held in a cast-iron collar; therefore there is no danger of the globe being dropped by the bending of the globe holder, which frequently happens when sheet metal or spun holders are used. It is held in place by a bayonet lock between the

FIG. 5.—DIRECT-CURRENT LAMP, WITH REFLECTOR.

FIG. 6.—ALTERNATING-CURRENT LAMP—OUTDOOR TYPE.

globe collar and the lamp, and, for the trimming, hangs suspended by two chains.

In redesigning the Sterling, special thought has been given to the men who handle the lamps, with the result that inspectors and stationmen who have used lamps of the types having concealed parts will appreciate the fact that, in the Sterling, all parts are exposed when the casing is removed.

The design of the lamp is such that there are no cables which are likely to become entangled or break, no sliding contacts, no carbon tube which is likely to collect silicate from the carbon and become clogged, the upper carbon holder receiving the current by means of a strong, unrestricted cable. The lamp is strongly insulated, there are no bushings which are liable to breakage, and all parts are accessible and easily replaced. The lamp may be easily trimmed while hot

FIG. 7.—INDOOR TOP.

FIG. 8.—OUTDOOR TOP.

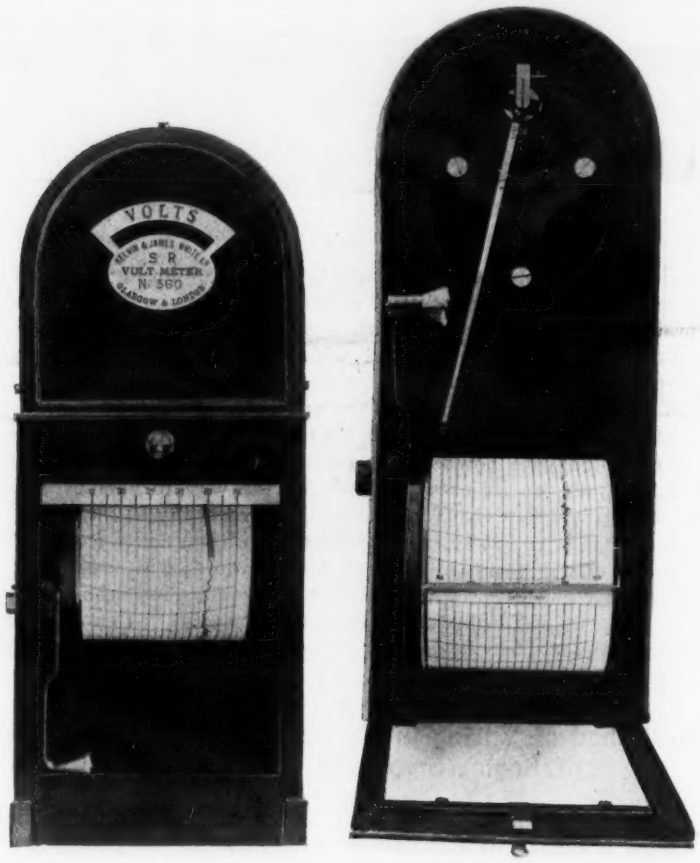
without even removing the inner globe, the only action necessary being to loosen the retaining plug in the lower carbon holder.

The direct-current lamps are built with two types of casings and two types of tops or hangers; one type for outdoor use and the other for indoor use. A lamp of one type may be changed to the other type by simply changing the casing and the top, or hanger, a screw driver being the only tool necessary. To change the alternating-current lamp from an outdoor to an indoor type, it is necessary to change only the top, or hanger, the casing being the same for either type. The two styles of tops are shown in Figs. 7 and 8.

New Recording Instruments.

Any improvement in the apparatus used in central station equipment which will obviate the necessity for careful manipulation and attention is welcomed by electrical engineers. The time and attention of central station operators are largely taken up by the instruments used for recording the various factors in electrical supply, and owing to the progress which is being made in station cost keeping, the demand for this class of instrument is continuously increasing, rendering necessary the employment of an instrument that can be placed in charge of an unskilled attendant. Messrs. Kelvin & James White, Ltd., of Glasgow, Scotland, have recently placed on the market a new type of recording instrument, the invention of that indefatigable veteran, Lord Kelvin, in which the method of winding the clock and the changing of the record sheets is accomplished in an exceedingly simple and ingenious manner. By a single movement of an operating handle, the clock is withdrawn from its case and simultaneously wound for the next record, the movement being such that the clock drum passes out of contact with the pen to a position in which the paper may be changed without any possibility of fouling the pen.

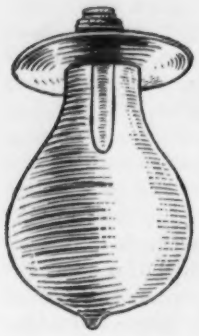
Another important feature of this instrument is that it is impossible to overwind the clock, even though the lever is repeatedly operated. This is accomplished by means of an automatic device which is thrown out of gear when the driving spring is fully wound. The record sheet is 18 inches long and the scale of the instrument about 4½ inches, the clock making one revolution in 25 hours, thus allowing half an hour spare at each end. On the assumption that the instrument



FIGS 1 AND 2.—CENTRAL STATION RECORDING INSTRUMENTS.

is attended to once a day, it has been thought inadvisable by the makers to provide a clock giving a longer record, as experience has shown that it is necessary to examine the clock at least once in 24 hours. They are prepared, however, to supply an instrument giving a longer record, if required. A receptacle is provided inside the instrument for a year's supply of record sheets, and a file for completed charts accompanies each instrument. The devices above referred to are fitted to all of Lord Kelvin's recording instruments used in the measuring of watts, volts and amperes on direct and alternating, single and polyphase circuits. In the accompanying illustrations, Fig. 1 shows the instrument case closed, and Fig. 2 shows the case open and the clock withdrawn into the position for fitting a new record sheet, the clock having been wound in the operation of withdrawal.

An Electric Sign Device.



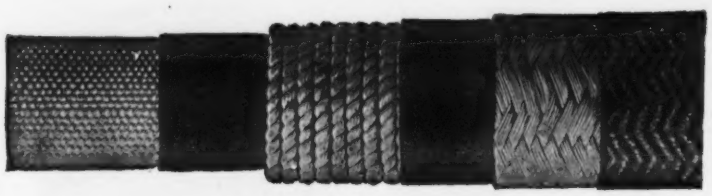
ELECTRIC SIGN DEVICE.

The Norden Bittner Electric Company, 1402 Broadway, New York, is putting on the market a new form of electris sign which is interchangeable, as each monogram contains every letter and number in the alphabet, and when once installed any changes can be made at will without removing the letter from its position. The little disk behind the lamps, as shown in the cut, makes it a day, as well as a night, sign.

These are especially valuable for theatres or places where a different display sign is often desired, as with one set of letters any combination can be made. No painting is necessary, as disk, being white enamel, brings the reading out thoroughly in the day and is used as a reflector in the night.

Alphaduct Fire-Proof Fibre Conduit.

A new interior conduit has been put upon the market by the Alphaduct Manufacturing Company, of 522 West Twenty-third Street, New York City. The interior of tube is heavy canvas duck thoroughly fireproofed by approved process. This is covered with a slow-burning flexible weatherproof compound, over which is spirally wound hard twisted cable cord, thoroughly fireproofed. All interstices between the cord are then filled with a special compound, the whole



ALPHADUCT FIREPROOF FIBRE CONDUIT.

forming a wall impossible to carry fire from any inside connection. Over this a protecting jacket of cotton, fireproofed as above, is then braided, and finally coated with a slow-burning flexible weatherproofing compound and dusted with a powder to prevent adhesion.

The interior of the conduit is the smooth, hard finish of the cotton duck, which is very easy to finish, but to make it perfect in this regard it is dusted with powdered soapstone, which acts as a lubricant, rendering the surface very smooth for the wire to pass by. The manufacturers state that Alphaduct will not carry fire.

It is manufactured by a patented and original process designed to combine all the most highly approved and up-to-date ideas as to what is desirable and essential in a conduit of this class for electric wires. The make-up of "Alphaduct" is carefully restricted to approved substances, so there may be no deterioration in the manufactured article. A sectional cut of the conduit is herewith shown.

A Method of Wiring in Connection With the Operation of Engine Stops and Electric Motors.

The necessity and importance of stop mechanism for engines and motors is abundantly emphasized by the extended recognition given them by manufacturers and property owners, and any system of wiring is of interest and importance which will increase their efficiency or assures a greater certainty of their successful operation. Illustrated herewith is shown a system of wiring, devised by F. S. Palmer, 100 Broadway, New York City, to meet these requirements.

Fig. 1 shows a slate board upon which is mounted a double-throw switch. A single-throw switch is also shown operated by electricity, a high resistance bell, a small single-throw switch, and binding posts 1, 2, 3, 4, 5, shown in Fig. 2. The board is to be located at some desirable place in the building where the engine or motor is to be stopped from any section or floor by the use of circuit-closers, *C C*, in Fig. 2. The double-throw switch is used to test all the wires and ring the high-resistance bell without operating the stop mechanism. The small switch is used to operate the motor switch or stop mechanism as often as desired, thus keeping them in active use.

Fig. 2 is a detail drawing of the method of wiring any engine stop mechanism, showing circuit-closers on three floors. To operate the engine stop or open the motor switch, the circuit-closer, *C C*, is used—say third floor. The current passes from battery to binding post, 5, engine stop magnets or electric switch for motors, to post 4, post *A* on the test switch to *B*, to post 3, circuit-closer, *C C*, third floor, to post 2, to battery, or from battery to post 5, to stop or switch as above to post 4, to circuit-closer, *C C*, to post 2, to battery. Thus it will be seen that should one or both wires connected to circuit-closer, *C C*, on the third floor, be cut, the closer will remain operative.

To test the wire and battery the test switch is thrown so that the blades rest in the knives at *E* and *F*. The wires are then in series

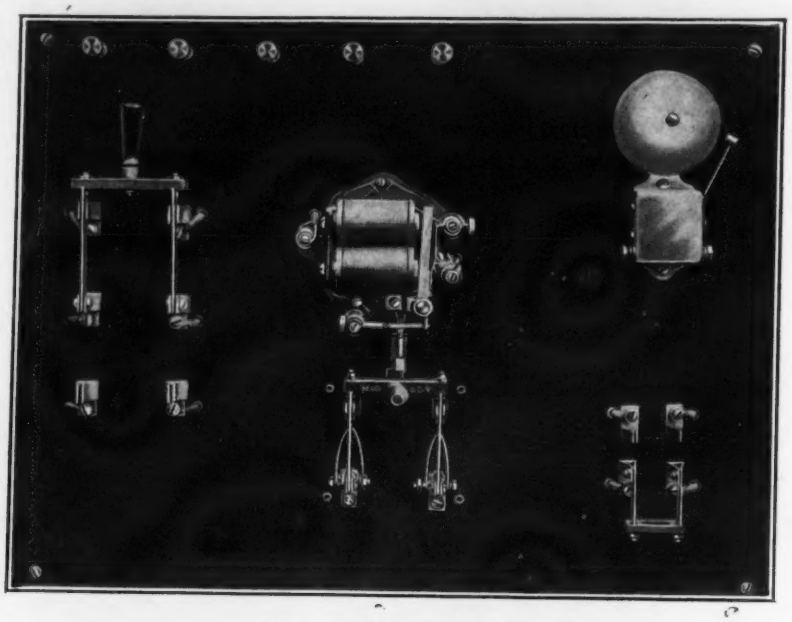


FIG. 1.—SWITCHBOARD.

with the magnets of the stop or motor-switch magnets by the use of any circuit-closer, while should there be any break in the wires the bell will fail to ring at test.

It will readily be seen that the operator in charge of this apparatus would be very negligent if he permitted it to get out of order. He can use the small switch for stopping either engine or motor every day if he chooses, thus assuring himself that everything is in readiness for stopping the same from any floor in the building.

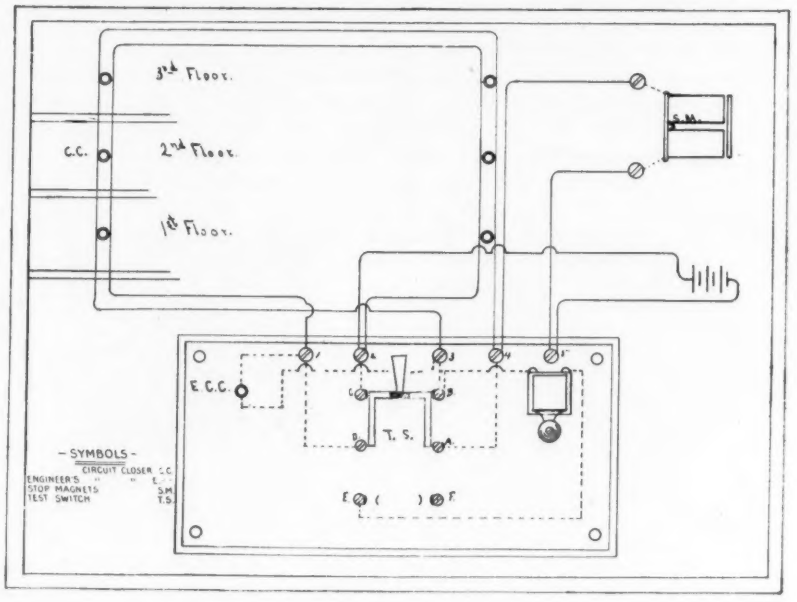


FIG. 2.—DIAGRAM OF CIRCUITS.

Arrangements can easily be made to notify outside parties of any shut-down if desired. The method of operating stop magnets is also arranged with annunciators to indicate the floor or section in which the circuit-closer has been operated, also to make record of all tests.

Turbine Installation of the Ottawa & Hull Power and Manufacturing Company, Hull, Canada.

Situated at Hull, Que., is the power house of the Ottawa & Hull Power & Manufacturing Company, in which is installed at present two generating units of 2,600 hp each, under a head of 27 feet, and two exciter units. Provision is made, however, for the installation of two more units of the same capacity. The flumes are formed of structural steel and concrete, and the I-beam foundation frames supporting the wheels and the steel bulkheads through which the shafts pass are built in. The head varies from 25 to 35 feet, with an average head of 27 feet. Each generating unit consists of a 1,500-kw, direct-connected, two-phase generator built by the Canadian General Electric Company, of Peterboro, Ont. The generators and turbines run at a speed of 138½ r.p.m. The generators are guaranteed to carry a 50 per cent. overload for two hours. The turbines for each generating unit are four in number, connected tandem, and were built by the Dayton Globe Iron Works Company, of Dayton, Ohio, and are of their latest improved cylinder gate draw-rod type. They are mounted on two cast-iron draft chests, with draft tubes 9 feet in diameter (Fig. 1). The wheels proper are of the new American type, made in one continuous casting, 51 inches in diameter, and when tested at the Holyoke testing flume gave an efficiency of 86.71 per cent. at full gate. This wheel is one of the most efficient ever tested in the Holyoke flume. The shafts are made of steel and were forged by the Bethlehem Steel Company. They are in two pieces each, with intermediate coupling flanges forged on. They

FIG. 1.—TANDEM-CONNECTED TURBINES.

are 5 7/16 inches in diameter at the remote ends, increasing in size to 10½ inches in diameter at the driving ends. The gate is of the well-known cylinder draw-rod type and has several features not usually found in this class of gate. The gate proper slides on ways similar to those on a steam engine. On these ways or guides are adjustable gibs, which can be operated by bronze set-screws, thus taking up the wear and keeping the gate from touching or rubbing the inlet chutes on the bottom. The gate rods are fastened to the gates in the center of these guides or ways, bringing the line of force and that of resistance on the same plane, thus obviating the tendency to tip and bind which is most objectionable in ordinary cylinder gates when operating horizontally. This method of operating gates has proven so successful that the manufacturers have patented it.

Another feature of this device is that all gearing racks, etc., are outside of the flume, away from the water, and accessible at all times. This entire mechanism is mounted on the main bridge-tree, as shown in Fig. 1. It consists of two vertical shafts on each side of the bridge-tree, on which are placed cut pinions to move the cut racks on the gate rods, the rods passing through the stuffing boxes in the flume head. In order to bring the line of action in the center of the gate bearings, three draw-rods are used. The upper and lower rods act in conjunction with one another and move the gate of the second and fourth wheels through yokes and hollow tubes, Fig. 1. The gate-rod on the wheel, No. 2, is a hollow brass tube so as to allow the center gate-rod which operates the gates on wheels No. 1 and 3 to pass through for a connection to gate No. 3. The two lower pinions on the vertical shafts on the bridge-tree are connected to the transverse or operating rack by an intermediate gear (not visible in the cut), thus causing all the gate-rods on both sides of the wheels to move in unison. The governor and hand-operating device is connected to the transverse racks by a pinion working into the racks shown on the end.

The gears and racks are supported by a cast-iron frame of the bridge-tree and are also stayed to the flume head by large stay-bolts, thus giving the entire structure great rigidity, and maintaining a compact design, the principal elements of which have been patented. All the bearings in the water are of lignum vitæ and are adjustable by bronze set-screws for taking up the wear. The thrust is taken care of by lignum vitæ thrust bearings on the rear end of the shaft. The governors are of the Woodward compensating type and were built especially for this installation.

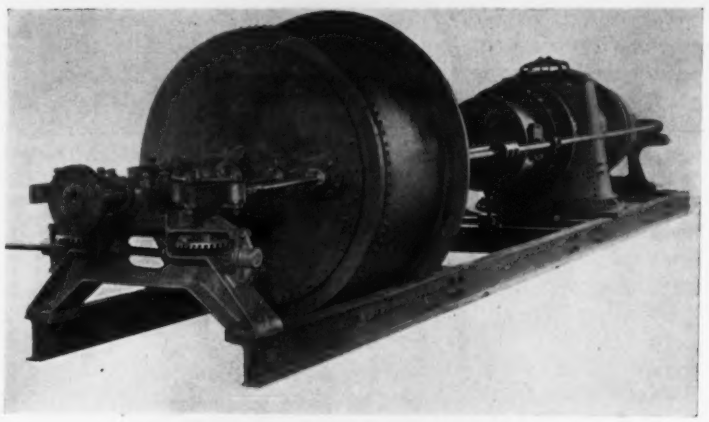


FIG. 2.—EXCITER TURBINE.

The turbines for the exciter units are shown by Figs. 2 and 3 and are of the cylinder gate draw-rod type similar to the generating units. There are two sets of two wheels each of the new American type, 22 inches in diameter, mounted on sheet steel draft chests, the whole mounted on steel I-beam foundations, built in the concrete. The gate operating mechanism is the same in principle as that of the large units, but not so complicated, as there are only two wheels in each unit to control. The governors on these units are the Woodward compensating type. Fig. 2 is a front view of the exciter unit showing the gate gearing and racks mounted on the bridge-tree, also the bulkhead ring in position. Fig. 3 is a rear view showing the connecting yoke for the gate-rods. This view also shows the

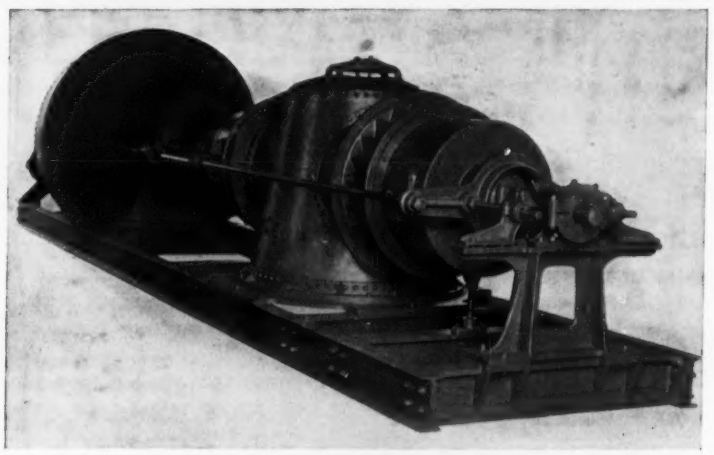


FIG. 3.—EXCITER TURBINE.

position of all the gate-rods on the center plane of the shaft. This installation was made under the supervision of Mr. Wm. Kennedy, Jr., hydraulic and mechanical engineer, of Montreal, Que.

Nail Puller for Electrical Purposes.

The Smith & Hemenway Company, New York, is putting on the market a very neat nail puller for electrical purposes. It weighs only 2½ ounces and is very small and can be carried in the pocket for pulling small nails with the assistance of a claw hammer. It can be used in connection with any ordinary hammer and weighs 6½ ounces. No electrician can afford to be without this, as it will assist him very materially in taking nails from strips covering insulating wires. It has been remarked that the nail puller manufacturers of the United States have heretofore overlooked the specific necessities of the electrician.

Improved Telephone Power Generator.

Power generators for telephone work have often had one serious fault, due to the poor construction of the commutator or collector. In the new machine here shown, Fig. 1, it has been the principal aim of the Connecticut Telephone & Electric Company, of Meriden, Conn., to overcome this weak point. By referring to the cut, Fig. 2, it will be noted that the commutator or collector ring is made with a

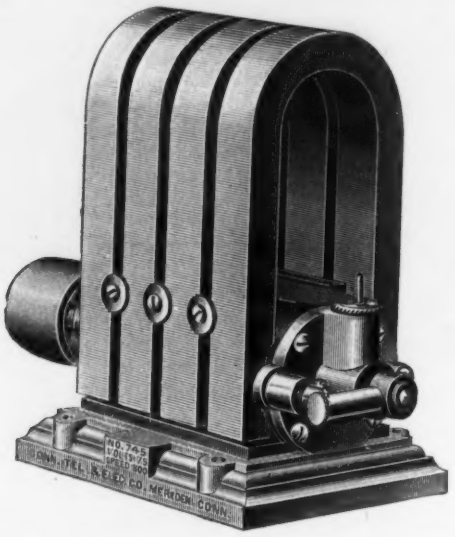


FIG. 1.—TELEPHONE GENERATOR, COMPLETE.

taper plug hole to fit a corresponding taper plug on the end of the shaft, this plug being one terminal of the armature winding. It is held in place by means of a washer or screw on the end, and when the commutator becomes worn, it is simply necessary to remove the screw or washer and substitute a new ring, all rings being interchangeable. The brush is of the carbon pencil type, will last a very long time, and is renewed in a moment. In addition to this, they have enclosed the armature chamber, so that it is impossible for dirt or

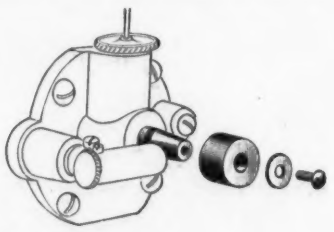


FIG. 2.—DETAILS OF BEARING.

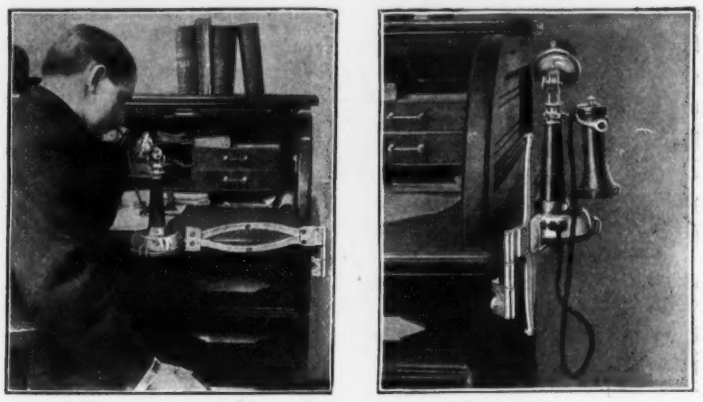
foreign substances to work into it. The bearings are all made of special bronze metal and supplied with automatic grease cups; the pole pieces are of the softest iron obtainable and are carefully bored out. The armature is of the laminated type, ground on centers, so as to make it absolutely true. Ordinarily a 1-inch face flat pulley is supplied on this machine, but a grooved pulley for round belt can be furnished when wanted. The machine is also made up with eight magnets where extra heavy output is desired.

The Chicago Telephone Holder.

The desk telephone is finding an increasing use, because of its greater convenience over the instrument mounted on the wall; but along with the desk telephone has come the problem of a good place to keep it, where it will be handy and quickly available at any instant, while at the same time out of the way of other matters on the desk. There is practically no place provided on a modern office desk for a telephone. The top of the desk is not suitable, because of the roll top; the leaves are needed for other purposes than holding a telephone. A shelf at one end of the desk necessitates lifting the telephone desk set every time it is used. In fact, the same might be said of almost every position in which a telephone can be put around a desk. An ordinary swinging bracket takes up considerable room in swinging and then does not bring the instrument to the position most convenient.

The Chicago telephone holder is simply a swinging bracket which can be pulled out full length or closed up instantly, and with very slight effort. The rapidity with which the telephone can be pulled out within talking distance and the small amount of effort required to do it, makes the device popular at first trial. The two accompanying engravings show the construction of the device better than any description. It practically keeps the telephone out of the way all the time when not in use, and yet places it within instantaneous reach.

Another point which should recommend it to telephone companies is that the instrument is clamped to the holder, so that it cannot fall and break. As the loss from breakage of desk sets is considerable, the use of telephone holders by any company's subscribers is sure to save much trouble and annoyance, for even if the subscriber



FIGS 1 AND 2.—TELEPHONE HOLDER.

has to pay for broken instruments, there is always a chance for complaint and hard feeling in connection with it.

The Chicago telephone holder is manufactured by the Chicago Writing Machine Company, of which F. W. Pardee, 119 La Salle Street, is general agent.

Ventilated Motors.

Messrs. Robbins & Myers Co., Springfield, Ohio, have added to their line of motors an improvement recently patented, consisting of an effective ventilating arrangement. As is well known, all good motors of a given rating run at practically the same efficiency. From 80 per cent. to 90 per cent. of the power consumed is delivered at the belt of the motor and at the line wires of the dynamo. The remaining 10 per cent. to 20 per cent. (this varying somewhat with the output of the machine) is used in generating heat in the machine. The readiness with which this heat is gotten rid of determines the running temperature and probable life of the machine. This objectionable heat is gotten rid of by convection and radiation. The radiation from the outside of all machines of like rating is practically alike. The radiation from the inside, where the heat is all

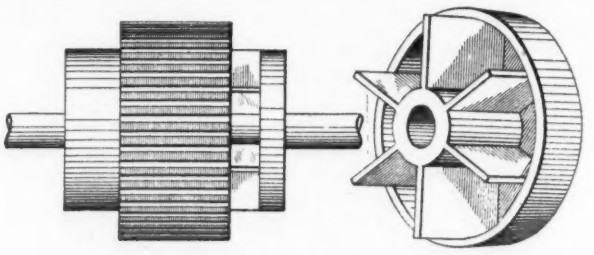


FIG. 1.—VENTILATED ARMATURE CORE.

directly generated, depends entirely upon the ventilation. The improvement above referred to relates to this latter consideration.

As applied, the armature core is built up of thin discs of iron stamped like a toothed wheel having a deep rim, three spokes and a hub fitting the shaft and key. These discs when assembled on the shaft are compressed between two castings of peculiar shape, one acting as a funnel and the other as a blower fan. These castings also serve to support the machine-wound armature coils, which are placed in slots left for this purpose in the armature discs, with their ends bound to the drums on the end castings by wire bands. These coils are so placed as to overlap and to leave ventilating holes

between the adjacent coils. When the armature is in motion the blower fan draws a large volume of fresh air into the rear of the motor through the funnel casting and through the tunnels left between the spokes of the discs, and blows it out through the interlaced windings, taking with it the heat from the armature core and

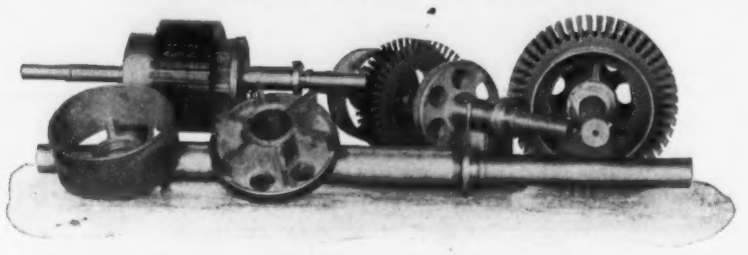


FIG. 2.—PARTS OF MOTOR.

windings, and insuring cool running, thus greatly increasing both the life of the machine and its overload capacity. The accompanying illustrations show the details of the construction.

A New Telephone Ringer.

In the accompanying illustrations, Figs. 1 and 2, is shown a new ringer, recently placed on the market by the Stromberg-Carlson Telephone Manufacturing Company, of Rochester, N. Y., and Chicago, Ill. The ringer is said to embody new and simple features in

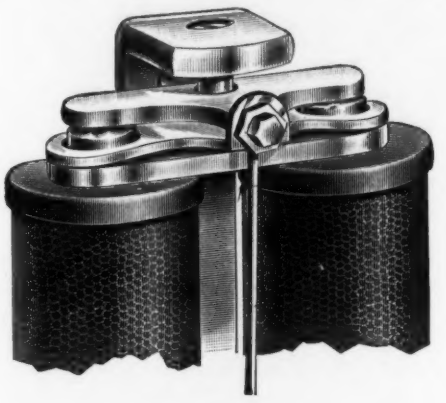


FIG. 1.—TELEPHONE RINGER.

the matter of adjustment. In Fig. 1 is a complete view, while in Fig. 2 is shown the armature end of the ringer, which is almost self-explanatory as regards the manner in which adjustment is made. A word of explanation, however, may not be amiss. It will be observed upon examination that a screw passes through the permanent magnet, armature, armature-frame support, and is threaded into the armature yoke. By turning this screw, a shoulder

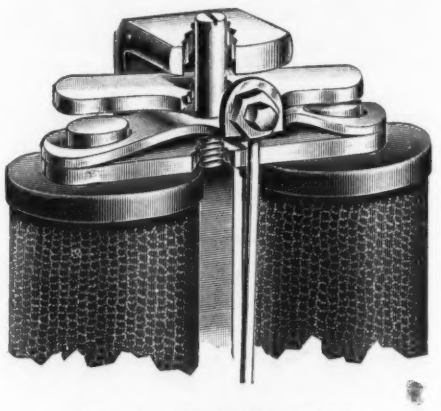


FIG. 2.—TELEPHONE RINGER.

on the screw is made to engage against the frame, which supports the armature and this, being made of spring steel, allows it to be pressed downward, thus bringing the armature nearer the cores, while the turning of the screw in the opposite direction allows the distance between the cores and armature to be increased. This adjustment is very simple and requires the turning of only one screw, which may be done as easily after the ringer is mounted in a telephone as before.

Electric Signs and Central Station Business.

It is beginning to be appreciated by a number of central station companies that it is good policy to encourage and even to solicit electric sign business. The Chicago Edison Company has for some time made it a practice to furnish a certain type of sign free of charge to all customers who will sign contracts for the supply of electric current to such signs. As revenue-producers, these signs are second to no other branch of the electric lighting business.

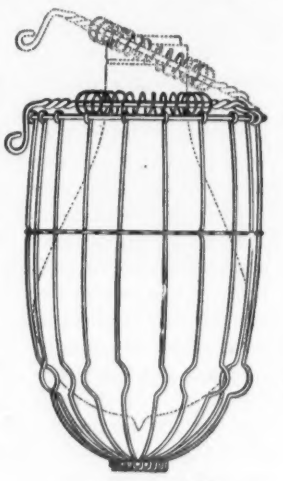
The signs adopted by the Chicago Edison Company are made by the Federal Electric Company, of Chicago. These signs have all parts so standardized that central stations can invest in them with the certainty that they will have no difficulty in changing them to suit different requirements. The Federal Electric Company owns a broad patent on the use of a hollow metal frame, surrounding a sign and containing incandescent lamp sockets. The signs made by this company are entirely of metal, and so meet the fire department requirements in any city. The principal metal going into their construction is heavy sheet-steel, enameled with an enamel baked on at very high temperature, which is extremely durable. All of the signs this company makes consist essentially of this hollow frame, into which the sign proper can be slipped. The frames are made up in quantities and the sign only is made to order.

The sign itself is simply an enameled sheet of steel, lettered according to the requirements of the user. A new form of socket will be used hereafter, which will have a heavy porcelain shell fastened directly to the frame of the sign. No screws will be required to hold the socket, and high insulation as well as great stability will be secured. Lamps of 4 cp requiring four watts per candle are on all the signs. A twenty-four-light sign, using the equivalent of ten 16-cp lamps, is maintained by the Chicago Edison Company for any customer at $2.50 per month, to be lighted from dark until midnight.

The company has an income of about $60,000 per year already from this class of signs. They are not intended to compete with the large illuminated signs, in which letters are spelled out with incandescent lamps, but are designed more especially for the smaller merchants, who wish to make a showing without the expense for current involved in the large signs.

Lamp Guards.

The new lamp guard known as the "Never Break," recently introduced to the trade, has several new features. The main principle is to suspend the lamp inside the steel wire cage, free from the outer protecting wire, so that the lamp is protected by the outer wires from a blow or from being dropped. The corrugated spring wires are reversed so as to engage the top and hold the lamp back from the end; and the spiral holder at the bottom forms a perfect cushion. The guard is made of steel spring wire, and the silver luster finish makes it attractive and durable. The adjustable clamp socket holder fits all regular size lamps without screws or loose wires, as used in the old construction. The illustration shows the ingenuity employed in accomplishing a very much desired result. Special grades and kinds are made. One especially useful is called a "chip" guard, which is covered with a fine steel wire gauze that prevents all flying chips and small slivers from breaking the glass bulbs in machine shops, foundries, etc. The Hamblin & Russell Mfg. Co., Worcester, Mass., is the manufacturer and owner of this guard, which has received insurance approval.



LAMP GUARD.

Recording Voltmeters and Ammeters.

The accompanying illustrations show a type of recording voltmeter or ammeter made by Nalder Brothers & Thompson, of London, which are made for both direct and alternating currents. For direct currents only a moving coil, permanent magnet, polarized type, is used, and for alternating currents a soft iron solenoid type has been perfected. This latter instrument can be used for direct as well as for alternating current. For swithboard use the apparatus is mounted either on enamel cast-iron cases or on enamel slate bases with polished mahogany glass-fronted cases. A line of portable instruments is also made which are mounted in polished teak cases fitted with leveling screws and leather strap handles.

The record is make on a revolving chart carried on a drum in the ordinary type of instruments, but where it is desired to record continuous runs a strip of paper, 60 feet long, can be usde, which will give over a month's record in one length. This latter arrangement is very useful in cases where for any reason it is not possible to

RECORDING AMMETER.

give the instruments daily attention, but is, of course, more complicated than a single-revolution chart. The drum is operated by clock work, having a well-made lever movement, and is capable of being accurately regulated. To prevent the movement from being strained the drum is driven through a friction coupling. The record is traced on the chart by a pen carried lightly over its surface. By an ingenious mechanical arrangement the pen presses firmly against the chart, but adjusts itself to any small irregularities which may be present on the surface. The pens are so designed and fixed that they give a perfectly continuous record under the most unsteady load and are so arranged that the ink cannot be thrown out by jerks of the pointer, caused by sudden current fluctuations. An important feature of recording instruments for rapidly varying currents is that they be correctly damped, and this detail has been carefully perfected in the type being described. If there is insufficient damping the fluctuations of the current will be greatly exaggerated, while, on the other hand, if the damping be excessive the quicker variations will not be shown on the records at all.

The illustrations show the direct-current instrument as supplied for switchboard use with black enamel cast-iron case. The lower portion is hinged and opens outward, so as to give easy access to the drum, for the purpose of renewing the chart. The drum itself is pivoted so that it can be readily removed from under the pen, and the apparatus easily recharted. This instrument may be equipped with anti-vibration cradles, which enable it to be used directly on a car.

Pumps for Central Stations.

The new power plant of the Manhattan Elevated Railway Company, New York City, has in operation six of the single-acting triplex plunger pumps recently introduced by the Goulds Manufacturing Company, of Seneca Falls, N. Y., who have also sold four of them to the Tide Water Oil Company for use on their pipe line to Titusville, Pa., to work against 900 pounds pressure. This type of pump has a frame comprising two standards which carry the main bearings and the seats for the two outside cylinders; and the seats to which the outside crosshead guides are bolted. These are held together by the center crosshead and the seat for the center cylinder. The crank shaft is a steel forging and its bearings are phosphor bronze, while the pinion shaft bearings are of babbitt metal. The connecting rods have bronze boxes with strap edge and wedge adjustment at the crank

SINGLE-ACTING TRIPLEX PLUNGER PUMP.

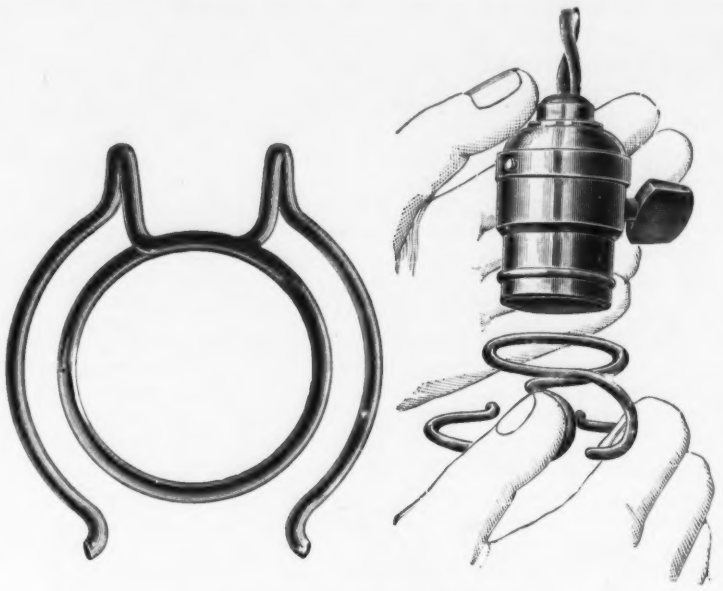
end and adjustable bronze boxes, marine type, at the crosshead end. There is double gearing and in practice a gearguard covers the pinion and the adjacent teeth of the gear. The valve boxes are separate charcoal iron castings, each containing a set of suction and discharge valves. Pipe connections are made at either end of the pump. This strong and compact pump is designed to work under 200 to 1,500 pounds working pressure, or 500 to 3,500 feet elevation, for electrical plants, mining, water supply, etc.

A New Type of Shade Holder.

One of the newest time-savers for lighting is a shade holder manufactured by William V. Geis & Co., of Far Rockaway, N. Y. The old familiar form is made with a metal strap or band which fastens with a screw around an incandescent lamp socket, necessitating a tool to adjust it properly. In order that the shade might be placed in the old holder it is necessary to operate three thumb screws so that the shade may be held firmly.

The new device is made of brass spring wire and is placed in position with absolutely no tools. It may be put on a lamp socket with one hand, is rigid when in place and does all of the work that is

expected of any shade holder. It is lacquered and will not tarnish. Fig. 1 shows the shade holder. Fig. 2 shows how by merely taking hold of what might be termed the back end of the holder and pressing the thumb and forefinger together slightly, the ring is opened so that it may slip over a lamp socket springing back into place when the



FIGS. 1 AND 2.—SHADE HOLDER.

pressure is released. This then gives two protruding ends or jaws immediately below the socket into which the shade holder is forced, the ends bending slightly to receive it and springing together, holding the shade very firmly. Fig. 3 shows the complete device.

FIG. 3.—SHADE HOLDER.

This form of shade holder is a radical departure from those put on the market heretofore. It has already been well received by dealers who are prompt to realize the economy of time in installing such a fixture.

New Apparatus for Lighting and Power in New York City.

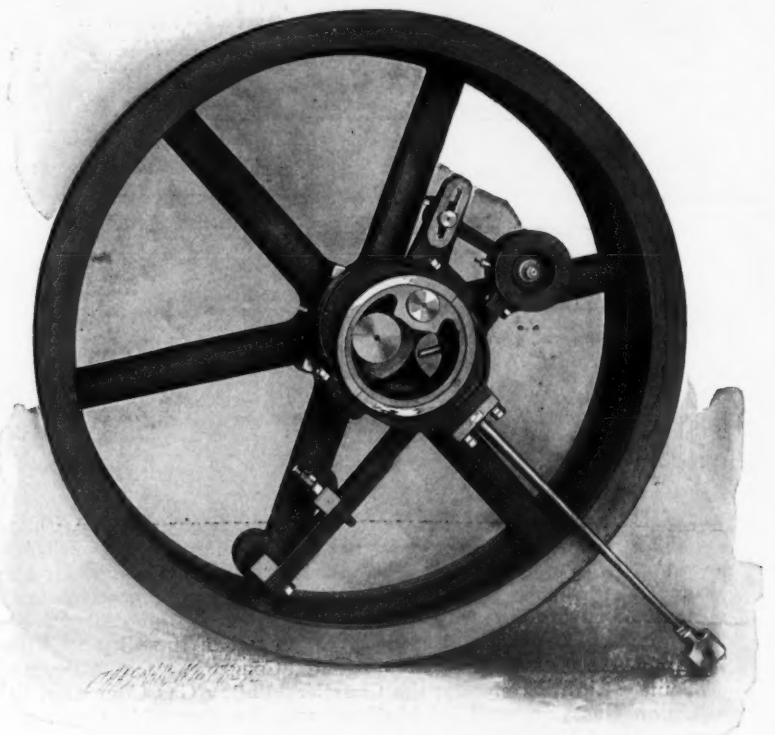
Since its reduction of the price of current, the constant growth of the demands for station power has made it necessary for the New York Edison Company to make arrangements for new generators, rotary converters and transformers. The Stanley Electric Manufacturing Company has secured, through its New York office, this important contract, which is notable not only on account of the total amount involved, but also because of the unusual size of the units. The first item in the contract is for four 2,000-kw, S.K.C. rotary converters. The transformer equipment to accompany the same consists of twelve 800-kw, S.K.C. static transformers of the air-blast type, and four auto-regulators. As is generally known, the largest rotaries hitherto built are the 1,500-kw units in the Manhattan substations, and therefore the construction of those of 2,000-kw capacity marks a distinct advance in the art.

In addition, the contract calls for ten 1,000-kw, S.K.C. rotary converters with thirty 400-kw, S.K.C. static transformers of the air-blast type, and ten auto-regulators. The above apparatus is to be placed in various sub-stations of the Edison system. Furthermore, the Stanley Electric Manufacturing Company are to furnish three new generating units for the Waterside Station. The machines are to be 3,500-kw, 25-cycle, 3-phase, alternating-current generators, direct-connected to engines working at 75 r.p.m.

Ball Engine Governor.

The Ball Engine Company, Erie, Pa., has, during the past year, developed a new engine governor, which is now being used on all engines made by the company. While a true inertia governor, the inertia feature is kept in proper subordination to the centrifugal element. This in connection with a gravity balance and absence of friction makes the governor remarkably quick in action. The construction is such that the strain of the spring and the centrifugal force of the weight balance each other without transmitting any of the strain through bearings or pivots. The governor is thus practically in gravity balance, with the result that its action is extremely steady and reliable, with non-liability to derangement or deterioration from wear.

The adjustments for speed and regulation are very simple. The spring is screwed up until the proper speed is obtained; then, if the engine races, the link pin, which bolts to the eccentric arm, is moved farther away from the eccentric. If, on the other hand, the governing is not close enough, this pin is moved toward the eccentric, a row of holes being provided in the arm of the eccentric for this purpose. These adjustments are the only ones necessary to produce fine regulation at any speed within the range of the engine, and the adjustment when made is permanent; moreover, to make them an expert is not required, which often saves a trip of hundreds of miles.



ENGINE GOVERNOR.

NEWS OF THE WEEK.

Financial Intelligence.

THE WEEK IN WALL STREET.—There was a fair demand for time money, but chiefly for short periods. Rates are 6 per cent. for 60 to 90 days; 5½ a 6 per cent. for four, five and six months. Holiday dullness prevailed on the stock market, which was accentuated by the renewed seasonable firmness of call-money rates. Brooklyn Rapid Transit was a feature, having a rapid advance on various indefinite but favorable reports. The steel stocks tended to recover ground on good buying, and Amalgamated Copper responded to the idea that better conditions and relations are approaching in the copper trade. Electrics closed with net gains on moderate trading. The greatest activity in tractions was, as already noted, in Brooklyn Rapid Transit, 148,140 shares of which passed hands. The closing price was 68⅛, a net gain of 3⅜ points. Metropolitan Street Railway closed at 139⅞, ex-div., being a net gain at 1⅞. In the railway list Manhattan was the exception and closed with a net loss of ⅛ point, at 146¼, the total sales being 28,100 shares. General Electric made a net gain of 1⅞ points, closing at 177⅞. The two Westinghouse issues showed up with more firmness, closing at 194½ for the common and 202 for preferred, these figures representing net gains of 1½ and 2¾ respectively. Western Union made a net gain of ⅜, closing at 88. American Telephone closed at 162½, being a gain of 1½, and American District Telephone gained 1 point, closing at 37½. In Boston American Telephone & Telegraph closed at an advance of 2¼ points, and General Electric 2½ points higher. Following are the closing quotations of December 30:

NEW YORK.

	Dec. 22.	Dec. 30		Dec. 22.	Dec. 30
American Tel. & Cable	87	86	General Electric	178	177⅞
American Tel. & Tel.	162⅛	164	Hudson River Tel.	...	...
American Dist. Tel	36	37½	Metropolitan St. Ry.	140¼	140⅛
Brooklyn Rapid Transit	65⅝	67¾	N. E. Elec. Veh. Trns.	...	...
Commercial Cable	..	169½	N. Y. & N. J. Tel.	160	161
Electric Boat	20	22	N. Y. E. V. T. Co.	9⅝	9½
Electric Boat pfd.	35	35	Tel. & Tel. Co. Am	...	...
Electric Lead Reduction	3	3	Western Union Tel.	88⅛	88¼
Electric Vehicle	3¼	3⅜	Westinghouse com.	184½	202
Electric Vehicle pfd.	9	9	Westinghouse pfd.	202	202

BOSTON.

	Dec. 22.	Dec. 30		Dec. 22.	Dec. 30
American Tel. & Tel	163	164¼	Western Tel. & Tel. pfd.	99⅛	99
Cumberland Telephone	125¾	124¾	Mexican Telephone	2	2
Edison Elec. Illum.	..	262½	New England Telephone	137½	138
General Electric	175	.	Westinghouse	98	99
Western Tel. & Tel.	23	..	Westinghouse pfd.	98	99

PHILADELPHIA*

	Dec. 22.	Dec 30		Dec. 22.	Dec. 30
American Railways	..	51⅝	Phila. Traction	97⅛	97⅜
Elec. Storage Battery	84	84*	Phila. Electric	8⅜	8⅜
Elec. Storage Battery pfd.	82	..	Pa. Electric Vehicle	..	..
Elec. Co. of America	9¼	9½	Pa. Electric Vehicle pfd.	..	..

CHICAGO.

	Dec. 22.	Dec. 30		Dec. 22.	Dec. 30
Central Union Tel.	..	..	National Carbon pfd.	97	97
Chicago Edison	..	175	Northwest Elev. com.	..	.
Chicago City Ry.	208	205	Union Traction	14	14¼
Chicago Tel. Co.	..	..	Union Traction pfd.	43	45
National Carbon	26	26			

* Asked.

FIGURES OF PHILADELPHIA COMPANY.—The Philadelphia Company and its affiliated corporations have published a report to stockholders for the month of November and for the eleven months of the calendar year, giving a comparative statement of earnings, expenses and net income of the Philadelphia Company, the Consolidated Gas Company, of the City of Pittsburg; the Allegheny Illuminating Company, the Allegheny County Light Company, the Chartiers Valley Gas Company, the Union Gas Company, of McKeesport; the Equitable Gas Company, and the Pittsburg Railways Company. The November statement shows substantial increases in net earnings as well as gross earnings, with a slight decrease in the net surplus due to an increase in the amount paid for dividends on the preferred stock and for interest on the funded debt. Gross earnings of the properties for the eleven months are $12,419,920, and net $5,371,859, a gain in net of about $400,000. The Philadelphia Company's interest in the net is $2,116,384, as compared with $1,636,906 last year.

LONG ISLAND LIGHTING MORTGAGE.—There has been filed in the office of the County Clerk of Queens County by the Queens Borough Gas and Electric Light Company, of Rockaway, a mortgage and deed of trust of $2,000,000 to the Guaranty Trust Company, of New York City, to secure an issue of 2,000 bonds of $1,000 each. The proceeds of 400 of the bonds have been used to retire two mortgages, one of $250,000 upon the property of the Queens Borough Electric Light & Power Company, and another of $150,000 upon the property of the Hempstead Gas & Electric Light Company, which was absorbed by the Queens Borough Company in May last. Another $400,000 is to be used for the acquiring of other property, and the remainder of the bonds will be disposed of from time to time as the money is needed for other projects the company has in view. The electric light company gave a simple mortgage to the Guaranty Trust Company in July, and this has been replaced by the mortgage and deed of trust, and has been canceled.

CENTRAL & SOUTH AMERICAN TELEGRAPH.—The earnings of the Central & South American Telegraph Company for quarter ended December 31, 1902 (partly estimated) compares with the estimated figures for the corresponding period a year as follows:

	1902.	1901.		Changes.
Traffic receipts	$265,000	$257,000	I.	$8,000
Expenses	93,500	99,500	D.	6,000
Net	$171,500	$157,500	I.	$14,000
Other income	5,000	3,500	I.	1,500
Total income	$176,500	$161,000	I.	$15,550
Dividends	115,884	115,884		.....
Surplus	$60,616	$45,116	I.	$15,500
Previous surplus	714,962	586,858	I.	128,104
Total surplus	$775,578	$631.974	I.	$143,604

The directors have declared the regular quarterly dividend of 1½ per cent., payable January 7.

OSWEGO TROLLEY DEAL.—W. P. Gannon, president, and E. G. Connette, manager, of the Syracuse Rapid Transit Railway Company, have closed a deal with C. Sidney Shepard for the street railway system of Oswego, operated by the Oswego Traction Company. The deal is important, because of its bearing on the fight between the Syracuse Rapid Transit Company and the Lake Side and Baldwinsville Railway Company for franchise right between Syracuse and Oswego, both companies desiring to build a road between Syracuse and Oswego. The purchase includes all of the first mortage bonds of the Oswego company and all but 10 per cent. of the capital stock and second mortgage bonds. The company's capital stock amounts to $300,000, the first mortgage bonds to $97,000, and the second mortgage bonds to $191,000, outstanding. The company operates eleven and one-half miles of railway, including all in Oswego, with lines running out to Beach Oswego and Minetta.

THE MEXICAN TELEGRAPH COMPANY reports for the quarter ended December 31 (partly estimated):

	1902.	1901.		Changes.
Traffic receipts	$105,500	$110,000	D.	$4,500
Expenses	22,500	24,500	D.	2,000
Net	$83,000	$85,500	D.	$2,500
Other income	13,250	12,927	I.	323
Total income	$96,250	$98,427	D.	$2,177
Due Mexican government	5,000	5,000		.....
Balance	$91,250	$93,427	D.	$2,177
Dividend	47,815	47,815		.....
Surplus	$43,435	$45,612	D.	2,177
Previous surplus	1,161,094	1,004.600	I.	156,494
Total surplus	$1,204,529	$1,050,212	I.	$154,317

The regular quarterly dividend of 2½ per cent has been declared, payable January 14.

TOLEDO RAILWAYS AND LIGHT.—The statement of earnings of the Toledo Railways & Light for November showed an increase of over 12 per cent. in gross earnings, a decrease of 2 per cent. in operating expenses and an increase of over 25 per cent. in net earnings. The statement reflects the success the new president, Mr. Everett, is having. The increase in gross amounting to $12,850 accompanied by a decrease in operating expenses of $1,456, resulted in a net increase of $14,315. The net earnings of eleven months ended November amounted to $656,594, being $44,664 in excess of the earnings for the corresponding period in 1901.

INTERNATIONAL STEAM PUMP.—The proposed issue of debenture bonds by the International Steam Pump Company to the amount of $3,500,000 will be used in part for rebuilding the Worthington pump works. It is proposed to remove the works from Brooklyn to a nearby point in New Jersey. The machinery of the Worthington plant has become somewhat antiquated and in addition more room is needed than the Brooklyn property affords. A portion of the proceeds will be used to increase the working fund.

DIVIDENDS.—The directors of the Bullock Electric Manufacturing Company have declared the regular quarterly dividend of 1¼ per cent. on the preferred stock. The Consolidated Traction Company, of Pittsburg, has declared an initial semi-annual dividend of 1 per cent. on the common stock, payable January 2. The bulk of this stock is held in the treasury of the Philadelphia company. The Knoxville Traction Company declares a semi-annual dividend of 1 per cent., payable on January 15. This company's stock is $750,000, divided into shares of the par value of $100 each. The Macon Railway and Light Company's stock has declared a semi-annual dividend of 2½ per cent. on its preferred stock of $300,000. This is a recent consolidation of the street railway and lighting interests of Macon, Ga. The Lexington Railway Company has increased its semi-annual dividend from 1 to 1½ per cent. Its capital stock is $800,000. The dividend is payable on January 15. In all three companies Baltimoreans, associated with the banking house of J. W. Middendorf & Co., of Baltimore, and John L. Williams & Sons, of Richmond, are interested. The Louisville Railroad has declared the regular quarterly dividend on the common stock of 1¼ per cent. and an extra dividend of ½ per cent. It has also voluntarily increased wages of one thousand employees one cent an hour, aggregating $40,000. The Philadelphia Company directors have declared a regular quarterly dividend of 1½ per cent. on the common stock, payable February 2. A dividend of ½ of 1 per cent. has been declared on United Traction Company, of Pittsburg, common stock, and of 2½ per cent. on the preferred stock, payable January 2 and January 20 respectively.

JERSEY UNITED POWER SALE.—Control of the United Power & Transportation Company of New Jersey has been sold to the Interstate Railways Company at $75 a share, payable in forty-year collateral trust gold coupon bonds, to be issued by the Interstate Railways Company. The bonds will be dated February 1, 1903, and will bear interest at the rate of 3 per cent. for the first year, 3½ for the second year, and 4 for the third year and thereafter. The Interstate Railways Company was incorporated recently in New Jersey, with a capital of $10,000,000 for the purpose of operating electric companies and street railways in Pennsylvania, New Jersey and Delaware. The United Power & Transportation is also a New Jersey corporation, chartered in 1899. Its authorized capital was $12,500,000, of which $3,125,000, par $25, full paid, is outstanding. Among the operations controlled by the company are the following: Edison Illuminating Company, Lebanon; Schuylkill Valley Traction Company, Trenton (N. J.) Street Railway, United Traction Company, Reading; Wilkesbarre & Wyoming Valley Traction Company, Wilkesbarre; Dallas & Harveys Lake Railway; Wilmington & Chester Traction Company, Wilmington City Electric Company, Citizens' Electric Light & Power Company, of Delaware County; Delaware County & Philadelphia Electric Railway, and several lines in the suburbs of Philadelphia.

Commercial Intelligence.

THE WEEK IN TRADE.—In commenting on trade conditions, *Bradstreet's* says: "Satisfaction with the old and confidence in the new year are the dominating features as 1902 draws to the close. The Christmas holiday trade, exceeding in most respects all records, proved to be a fitting crown to the year of almost unprecedented business and industrial activity." Industrial operations have naturally slowed down except where conditions, as in railway traffic, are such as to demand straining of every nerve to keep up with business offered to prevent a midwinter congestion, which might result in serious derangement. Not only are spring goods being ordered with freedom and confidence, but prompt delivery of the same is bing urged. Among the industries iron and steel, naturally quiet at this season of the year, continue to note the fuel scarcity which affects production of merchant furnaces east and west. Structural iron still leads in strength and demand, and some heavy orders are being placed. Plates, as well as rails, are heavily sold ahead. Railway building during the past year was the heaviest in fifteen years, showing a 12 per cent. increase in mileage over a year ago. In copper there is a better speculative feeling and talk of an improvement in the metal itself is heard. The closing quotations are as follows: Lake, 11⅝ a 11¾c; electrolytic in ignots, cakes and wire bars, 11½ a 11⅝c. Cathodes, 11¼ a 11⅜c., and casting stock, 11⅜ a 11½c. The business failures for the week ending December 25, as reported by *Bradstreet's*, numbered 166, against 225 the week previous and 219 the corresponding week last year.

NEW YORK SUBWAY CARS.—Contracts have been awarded for the copper sheathing of 500 cars to be used in the subway, and the cars are to be delivered in November, 1903, for the contemplated opening of service during the present month. Vice-President Bryan, of the Interborough Rapid Transit Company, which issued the contracts to the Metal-Plated Car & Lumber Company, states that the sheathing will be left unpainted and will present a brilliant red surface that would not require renewal. It would, he added, give protection against fire resulting from short circuits. August Belmont, president of the Interborough Company, is said to be seeking a type of car that can be used interchangeably in the tunnel and on the elevated lines. Two hundred of the new cars now ordered are to be built by the St. Louis Car Company, St. Louis, Mo.; 100 by the Wason Manufacturing Company, of Springfield, Mass.; 100 by the John Stephenson Company, of Elizabethport, N. J., and 100 by the Jewett Car Company, of Newark, Ohio. It is announced that at least 300 more cars of a similar type will be built in time for the opening of the subway in 1903.

WESTINGHOUSE ENGINE ORDERS.—Westinghouse, Church, Kerr & Company, Maritime Building, Bridge Street, New York, have just taken a contract for a 410-hp compound Westinghouse engine to be direct-connected to a Westinghouse generator for installation in the Newark (N. J.) plant of the Benjamin Atha Steel Company. The outfit will be used for general power purposes. The Colorado Fuel & Iron Company's plant at Bessemer, Colo., is to be furnished with two vertical cross-compound engines of 410 hp capacity each. Three 125-hp vertical gas engines have been ordered for general power purposes by the Marshall Foundry Company, Pittsburg, Pa. These machines will be operated by natural gas. They will be direct-connected to Westinghouse generators of 75 kw capacity each.

EUROPEAN EQUIPMENT FOR TOKIO LIGHTING PLANT.—The contracts for the additional power house equipment for the Tokio Electric Light Company will be filled in Germany and England owing to more favorable terms of delivery and better prices having been secured on the other side as compared with terms from the United States. The contracts call for 2,800 hp. The new equipment is to generate current for the railway company, which is now constructing some 20 miles. The generators will be built by Siemens & Halske, Berlin. The British electrical engineering and contracting firm of Dick, Kerr & Co., it is reported, will fill the contract for the remainder of the equipment.

PARAGUAY ELECTRIC LIGHTING PROJECT.—R. C. Treat, collector of internal revenue, American Tract Building, New York, is primarily interested in a project to construct a large electric lighting plant in the city of Asuncion, capital of Paraguay. The initial capacity of the plant will be 1,200 hp. Ultimately it will be extended with a view to furnishing energy to operate an electric traction system, it being proposed to electrically convert and extend the existing mule line, five miles in length, running from Asuncion to Villa Mora, the principal residential suburb.

2,000-HP MOTOR GENERATORS FOR TOKIO.—The American electrical engineering and contracting firm of Bagnall & Hilles, Yokohama, has secured the contract for the motor generators to be installed in the plant of the Tokio Street Railway Company, which, as mentioned elsewhere in this issue, will draw its power from the Tokio Electric Light Company's central station. The motor generators will have an aggregate capacity of 2,000 hp—five units of 400 hp each. They will be built in the United States.

AMERICAN MOTORS FOR JAPANESE ROAD.—American motors are to be used on the projected Kobu electric road, which is to be run in the vicinity of Tokio, Japan. The initial equipment will consist of 16 trains to be operated on the multiple control system. Bagnall & Hilles, Yokohama, took the contract. The Japanese house of Okura, New York offices Bowling Green Building, got the contract for the power house equipment. The generators and engines will be built by Siemens & Halske, Berlin.

BIDS WANTED.—The city lighting department of Elgin, Ill., out of $41,095 for the coming year, will spend $6,000 for a new 100-hp boiler and a new alternating-current generator. The Recorder, of Winona, Minn., Mr. Paul Kemp, will receive bids for an electric light plant, including internal fired boilers of 250 hp, 250-hp Corliss high-speed engine, 300 r.p.m.; condenser, belting, generators, etc. The city engineer is G. P. Coleman.

TRACTION BRAKES.—It is announced that the Standard Traction Brake Company, of Pittsburg, after January 1 will become the Westinghouse Traction Brake Company, controlled by the Westinghouse Air Brake Company. The brake will be made at the Wilmerding works.

WIRE FOR KOBU ELECTRIC RAILWAY.—The American Steel & Wire Company, of 71 Broadway, New York, has secured the contract, through Bagnall & Hilles, Yokohama, for 27 miles of No. 0000 wire for the new Kobu electric road, Japan.

FEED AND TROLLEY WIRE FOR SOUTH AFRICA.—The Federal Electric Company, 141 Broadway, New York, has just been allotted a large contract for feed and trolley wire for shipment to South Africa.

EXPORTS OF ELECTRICAL MATERIALS.—The following are the exports of electrical materials and machinery from the port of New York for the week ended December 20: Antwerp—20 pkgs. material, $674; 3 pkgs. machinery, $595. Amsterdam—6 pkgs. machinery, $217. Argentine Republic—28 pkgs. material, $730; 1 pkg. machinery, $12. British Possessions in Africa—12 pkgs. material, $721. British Australia—64 pkgs. material, $2,149. British East Indies—35 pkgs. material, $1,246; 12 pkgs. machinery, $1,068. Brazil —204 pkgs. material, $4,858. British Guiana—2 pkgs. material, $11. Barcelona—7 pkgs. material, $1,810. Berlin—3 pkgs. material, $800. Brussels—3 pkgs. material, $155. Budapest—1 pkg. machinery, $35. British West Indies—22 pkgs. material, $471. Central America—12 pkgs. material, $238. Colchester—5 pkgs. material, $549. Chili—127 pkgs. material, $3,478. Cuba—3 pkgs. machinery, $466; 147 pkgs. material, $5.512. Dutch Guiana—20 pkgs. machinery, $5,623; 3 pkgs. material, $40. Egypt—1 pkg. material, $50. Gibraltar—3 pkgs. machinery, $125. Genoa—9 pkgs. material, $163. Glasgow—19 pkgs. machinery, $940; 7 pkgs. material, $568. Havre—5 pkgs. machinery, $188; 46 pkgs. material, $2,200. Hamburg—10 pkgs. machinery, $450; 247 pkgs. material, $6,178. Hayti—8 pkgs. material, $113. Liverpool —24 pkgs. machinery, $2,874; 85 pkgs. material, $3,647. London— 10 pkgs. machinery, $720; 176 pkgs. material, $9,137. Manchester— 1 pkg. material, $52; 166 pkgs. machinery, $15,936. Mexico—167 pkgs. material, $3,288; 3 pkgs. machinery, $114. Marseilles—21 pkgs. material, $232. Madrid—1 pkg. material, $167. Newfoundland—7 pkgs. material, $41. Nova Scotia—30 pkgs. material, $378. New Castle—4 pkgs. machinery, $210. Peru—3 pkgs. material, $1,396. Rotterdam—11 pkgs. machinery, $1,565. Southampton—1 pkg. machinery, $75; 75 pkgs. material, $3,540. Sunderland—2 pkgs. material, $78. U. S. Colombia—13 pkgs. material, $937. Venezuela—4 pkgs. material, $276. Wigan—4 pkgs. material, $375.

MORE YANKEE LIGHTING EQUIPMENT FOR JAPAN.—The Hakata Electric Light Company, at Hakata, on the Island of Kuishu, southwest from the Japanese mainland, has placed a contract with the Japanese house of Takata & Company for duplicating its existing plant, which is of American manufacture. The generator will be Westinghouse Electric of 120 kw, single-phase, direct-connected with revolving armature, 2,200 volts, 16,000 alternations, operating at 1,000 r.p.m., and fitted with double-crown pulley, from which a 375-kw Westinghouse exciter will be operated. The engine will be an Ideal tandem compound one, 13 in. x 22 in. x 16 in., operating at 250 r.p.m., and belted to an Ideal steam separator, both from A. L. Ide & Sons, of Springfield, Ill., through F. W. Horne, of Yokohama, who represents the interests of the Ide people in Japan. The switchboard will be made in Japan. The instruments, however, are to be of American manufacture. The switches will be of the new Westinghouse oil break type, double and single-pull. The General Electric Company will furnish a Thomson recording wattmeter for the switchboard. The Knowles branch of the International Pump Company will furnish an 8-in. x 12-in. x 12-in. independent air pump and jet condensers complete, with vacuum breaking safety attachment, 4,800 pounds steam. The air pump will be brass lined and fitted with brass piston and piston rods. The valves are to be of rubber working in brass valve sets. The initial plant was put in during February, 1900.

HUDSON RIVER POWER.—As already intimated in these pages, the Hudson River Water Power Company, which has substantially completed at Spier Falls one of the largest dams in the country, will construct a second big dam at a point on the upper Hudson River six miles above the present dam and a third one near Conklingville on the Sacandaga River. Lands and privileges for the additional projects have already been acquired. It has been alleged that to carry forward these undertakings the stockholders have voted to increase the capital stock from $2,000,000 to $5,000,000. There are 50,000 shares of the par value of $100 each. President Eugene L. Ashley, of the Hudson River Water Power Company, denies the reports that the increase of capital stock is made for the purpose of developing further power resources. The stock holdings of the Hudson River Water Power Company include companies and plants in Saratoga, Ballston and Mechanicsville, and amount to over $3,000,000 and in order that the same may reflect in the holdings of the stock owners, the increase of capital was voted. It is proposed to put the stock on the market, listing it on the exchange. Already stock of the company has sold for 85. The company and its subsidiary companies now have contracts, it is said, which will yield an annual income of $1,100,000. A contract has just been made to supply the Brady lighting interests at Albany with all the power that can be spared.

PUEBLA WATER POWER SCHEME.—Press reports emanating from the City of Mexico to the effect that the British contracting firm of S. Pearson & Son, Limited, of which Sir Weetman D. Pearson is the president, had obtained a concession from the Mexican government for the generating of electricity in the mountains of the State of Puebla, which would involve an expenditure of some $12,000,000, are erroneous. American capitalists represented by F. S. Pearson, the consulting engineer of the Metropolitan Street Railway, as mentioned several months ago in the ELECTRICAL WORLD AND ENGINEER, are the parties interested in the scheme. The British concern which is at present engaged in the construction of the National Tehuantepec Railway, and somewhat similar undertakings in the Southern Republic has so far not engaged in any electrical enterprises with the single exception of some small work at Vera Cruz, where the harbor works have just been completed. Sir Weetman D. Pearson arrived in New York last week from Europe and left Saturday for Mexico.

SALES OF WESTINGHOUSE PLANT.—The New York Manufacturing Company, of York, Pa., builders of refrigerating apparatus, are equipping their works for electric power distribution, and have recently purchased from the Westinghouse Electric & Manufacturing Company a number of direct-current, 220-volt motors. The Union Abattoir Company, of Baltimore, is making large additions to the electrical equipment used for power distribution in its plant. A 200-kw, 7,200 alternations, two-phase, engine-type generator, with exciter, and two 40-hp motors have recently been purchased through Dr. W. A. Drysdale, constructing engineer, of Philadelphia, from the Westinghouse Company. This machine is an addition to the present plant, which consists of a 150-kw, engine-type generator and about twenty induction motors, ranging in size from 3 to 40 hp inclusive.

POWER IN MARYLAND.—It is stated from Baltimore that the extensive electric power plant being constructed on the Susquehanna River for supplying power to Baltimore, Wilmington and other towns in Northern Maryland and Delaware will be connected with a new railroad operated by the Tidewater & Susquehanna Company, capital $1,300,000. It will extend along the west bank of the Susquehanna River, following the old canal route from Havre de Grace, Md., to Wrightsville, Pa. It will connect with the Baltimore & Ohio and the Pennsylvania Roads at points near Havre de Grace. It will also tap the Maryland & Pennsylvania Road, as well as a branch of the Pennsylvania at Wrightsville and the main line of the Pennsylvania at Columbia, Pa. It is reported that Pennsylvania Railroad interests are connected with the new railroad project, which, it is intended, shall act as a feeder to the Pennsylvania from the numerous electro-chemical, metallurgical and other works to be established near the electric power plant.

STROMBERG-CARLSON TELEPHONE PLANTS.—The Stromberg-Carlson Telephone Manufacturing Company, of Chicago, Ill., and Rochester, N. Y., has recently closed a contract with Mr. W. A. Eckels, of Roudd, Iowa, for a fifty-capacity drop switchboard; with the Buckeye Construction Company for a one-hundred-capacity drop switchboard for Shawhaw, Ky., and a similar board of the same capacity for Centerville, Ky.; and with the Star-Line Telephone Company, Elmo, Mo., for a one-hundred-capacity drop switchboard, together with a quantity of telephones.

NORTHERN ENGINEERING WIRING CONTRACTS.—The Northern Engineering Company, 95 Liberty Street, New York, has undertaken contracts for the wiring of the recently burnt portions of the city of Paterson, N. J., which will involve an expenditure of at least $50,000. Contracts have also been taken lately for wiring the new plant of the Robins Belt Conveying Company at Passaic, N. J., and other contracts which in the aggregate will represent another $50,000.

WESTINGHOUSE MOTORS, ETC., FOR JAPAN.—Takata & Company have lately secured various orders for small motors for shipment to Japan. These machines will be of Westinghouse build. The Nagasaki Quarantine Bureau is to be lighted by a 10-kw Westinghouse, 125-volt, direct-connected Kodak generator, 390 r.p.m. The engine will be built by Robey & Co., Lincoln, England.

BALL ENGINE ORDERS.—Douglas & Co., of Cedar Rapids, Iowa, has recently purchased from the Ball Engine Company, Erie, Pa., an engine for electric service. Strouse Bros., of Baltimore, Md., are installing an electric plant c onsisting of 125-hp and 60-hp engines, direct-connected to Westinghouse generators. The Ball Engine Company furnish the engines.

EQUIPMENT FOR MEXICAN STEEL PLANT.—The Monterey Iron & Steel Foundry, of Monterey, Mexico, is to be furnished with a Harrisburg standard tandem compound engine, supplied through Mackenzie & Quarrier, New York, which will be direct-connected to a 160-kw General Electric generator for general power purposes.

MACHINE TOOLS FOR SOUTH AFRICA.—Young & Park, 45 Broadway, New York, have just secured a number of fair-sized orders for machine tools, to be shipped to South Africa. Several of the tools will be electrically operated.

REYNOLDS ELECTRIC COMPANY, of 221-225 Fifth Avenue, Chicago, has changed its name to Reynolds Electric Flasher & Manufacturing Company, and increased its capital stock from $2,500 to $15,000. It is doing a very large business in flashers, window signs, decorations, etc.

NEW ELECTRIC POWER TRANSMISSION IN CALIFORNIA.—The Northern California Power Company, which furnishes power to a great variety of industries in one of the most prosperous sections of California, has recently installed a 4,000 hp generating plant at the Cow Creek station, which is situated in the high Sierras and is typical of the many transmission plants which have recently been installed in California. The ultimate capacity of the station will be 8,000 hp when the demand for power reaches this amount. The company has already installed 3,000 hp at another generating station, known as the Battle Creek station, thus making the present total capacity of the company's electrical installation 7,000 horse-power. Among the industries supplied with power by this company are ore-smelters, the city waterworks at Red Bluff and Redding, and the operation of large air compressors at the Mt. Copper Company's mine at Iron Mountain. For lighting, current is also furnished to the cities of Redding, Red Bluff, and Willows, and the towns of Keswick, Cottonwood, Anderson, Corning and Vina. These towns lie along the Sacramento River and are located in one of the most fertile valleys in California. Irrigation is necessary on most of the land in this valley, and electrically driven centrifugal pumps are employed to raise the water to the irrigating ditches. This cheap method of placing in the hands of the farmer the ability to obtain water away from streams and creeks has made him independent of the great water companies and has rendered it possible to develop large areas of land which would otherwise be practically desert wastes. Many thousands of motors are already in operation in California driving pumps for irrigation work, and immense developments are yet to ensue from this application of electric power. The apparatus which the Northern California Power Company has recently installed in its Cow Creek station consists of two 1,500 kw, 3-phase, Westinghouse alternators, which will be driven by impact water-wheels supplied with water under a head of approximately 900 feet. The Company has also purchased from the Westinghouse Electric & Manufacturing Company the exciters, switchboard and raising transformers for this station. The transmission will be at 34,000 volts. The Battle Creek station is likewise equipped with Westinghouse apparatus.

C. & C. FOREIGN AND DOMESTIC ORDERS.—The C. & C. Electric Company, 143 Liberty Street, New York, has obtained within the past few days various orders from Great Britain, India, Cuba and Japan. C. R. Heap, of 37 Victoria Street, London, S. W., has sent in orders for eight motors varying from 5 hp to 10 hp. An 11-kw generator has been ordered for shipment to India for lighting use. From Havana an order has come for a 25-kw belted generator to be used for lighting purposes. The American Trading Company, Broad Exchange Building, New York, has requisitioned for a small generator to be sent to Yokohama. Among domestic orders recently taken by the C. & C. people is one for a 125-kw belted generator—the second order—for installation in the Rogers Locomotive Works, Paterson, N. J., where the machine will be used for supplying power for general purposes. The Wyoming Hotel Company, Chicago, has ordered for light and power use one 60-kw and one 40-kw generator to be direct-connected to 90-hp and 60-hp horizontal engines from the Ames Iron Works, of Oswego, N. Y. A 60-kw generator and a 40-kw one have been ordered for use in an apartment house now under construction at West Fifty-fifth Street and Broadway, New York. These generators will be direct-connected to 90-hp and 60-hp engines manufactured by the Ridgway Dynamo & Engine Company, of Ridgway, Pa. The Belgravia Apartment Hotel, Philadelphia, Pa., is to have 75-kw and 50-kw generators direct-connected to 110-hp and 75-hp engines, to be furnished by the Buffalo Forge Company. The new Corn Exchange Bank Building, William Street, New York, will be equipped with three C. & C. slow-speed motors—25 hp, 10 hp and 5 hp, for operating ventilating apparatus to be supplied by the B. F. Sturtevant Company, Boston, Mass.

AMERICAN ROAD FOR JAPAN.—The American electrical engineering and contracting firm of Bagnall & Hilles, of Yokahama, whose Mr. A. L. Bagnall is now on a visit to the United States, and is making his headquarters at the New York office in the Engineering Building, 114 Liberty Street, of the New York Insulated Wire Company, have recently secured an important contract for the Kaihen Traction Company, which operates a road 11 miles in length, one section of which runs from Kawasaki to the temple of the great Japanese god Daishi. The power house equipment consists of two 150-kw direct-connected generators built by the General Electric Company. The engines are 225 hp each, from the Skinner Engine Company, of Erie, Pa. The boilers are Philadelphia vertical & Sterling build. The Carnegie Steel Company has the order for the rails—60-pound. The trucks—24 in all—were ordered from both the J. G. Brill Company, of Philadelphia, and the Peckham Manufacturing Company, 26 Cortlandt Street, New York City. The car bodies are Japanese. This also applies to the trolley poles. The trucks are each fitted with two 25-hp General Electric or Westinghouse motors. It is anticipated that the system will be extended in the near future.

PORTO RICO TROLLEYS.—A special dispatch from San Juan, Porto Rico, says: The largest single investment of capital made in Porto Rico since the American occupation is about to flow into the island for railroad construction. The Executive Council has granted to the Vandergrift Construction Company, of Philadelphia, a franchise to build and operate an electric railroad from San Juan to Ponce, seventy-three miles, and also to sell light and power along the route. The concession is the most important yet given by the Insular Government, and it is the consensus of opinion here that the results will be of incalculable benefit to Porto Rico. The franchise gives to the Vandergrift Company the Comeria water rights, which are in themselves of great value if properly utilized. The Philadelphia concern, promptly acceding to the Council's request, has deposited $10,000 cash as an earnest, and must within the next sixty days file a bond of $100,000, satisfactory to the Attorney-General of Porto Rico, as to sufficiently fulfill the conditions of the ordinance imposed.

STROMBERG-CARLSON TELEPHONE CONTRACTS—The Stromberg-Carlson Telephone Manufacturing Company, of Chicago, Ill., and Rochester, N. Y., has recently closed a contract with the Cherokee Telephone Company for a 200-line-capacity drop switchboard. It has also recently closed a contract with the New Castle Telephone Company, of New Castle, Ind., for a 1,000-line-capacity, visual-signal, central-energy switchboard, consisting of four sections; also a two-position toll board equipped with 40 lines. A further Stromberg-Carlson contract is with the Southern Electrical Construction Company, of Huntington, Ind., for a 2,400-line, full-lamp signal, central-energy switchboard, with a present equipment of 700 lines for Bowling Green, Ky. The contract includes 700 telephones, a toll board, chief operator's desk and complete power equipment.

PUMPING AND HOISTING EQUIPMENTS FOR MEXICO.—The Descubridora Mining and Smelting Company, Thos. H. Watkins, president, and New York offices at 68 William Street, has let some important contracts within the last few days for electrically operated pumping and hoisting equipments for its mines at Descubridora, Mexico. The Allentown Rolling Mills, of Allentown, Pa., have been awarded a contract for three 4-inch by 12-inch horizontal mining pumps, capable of handling 200 gallons per minute against a vertical lift of 600 feet. These pumps will be each operated by 50-hp General Electric motors. A large double-drum electric mine hoist has been ordered from the Lidgerwood Manufacturing Company. It will be driven by a General Electric motor of 100 hp.

MORE YANKEE EQUIPMENT FOR NAGOYA ROAD.—The Nagoya (Japan) Electric Railway Company, which has American equipment, is to extend its operations. The American electrical engineering and contracting firm of Bagnall & Hilles has been awarded the contract for a 200-kw extension to the power house capacity and also for some cars. The original power house equipment consists of three 100-kw generators, Philadelphia Corliss engines and Sterling boilers. Mr. Bagnall, now in New York, has already ordered some car trucks from the Peckham Manufacturing Company. The motors will be double ones of 25 hp each. They will be built by the General Electric Company.

ELECTRIC HOISTS FOR SOUTH AFRICAN MINES.—The United Engineering Company, of Johannesburg, which handles considerable electrical and other machinery for installation in South African mines, etc., has placed an order with the Lidgerwood Manufacturing Company for three double-drum electric mining hoists of 25-hp capacity each. These equipments will be operated by General Electric motors.

LIGHTING FOR COLIMA, MEXICO.—The municipal government of the city of Colima, Mexico, has just entered into a contract with Fogarty & Dickerson, an American contracting firm of San Luis Potosi, Mexico, for the installation of an electric light plant in that city. The plant will be operated by the contractors for a period of twenty years.

THE MERIDEN (CONN.) ELECTRIC LIGHT COMPANY has placed with Stuart-Howland Company, Boston, an order for a complete new equipment of Helios-Upton series alternating arc lamps and regulators, and Peerless transformers for its street lighting service. The Stuart-Howland Company is the New England agent for these lines.

YOKOHAMA TO HAVE ELECTRIC TRACTION.—A Japanese syndicate with an initial capital of about $150,000 has been formed for the purpose of constructing an electric traction system in Yokohama which will mark the introduction of the trolley in that important city.

ANDERSON WIRING MATERIAL CONTRACTS.—The Albert & J. M. Anderson Manufacturing Company, of Boston, Mass., has been allotted the contracts for the wiring material for the new Battery Park and Corn Exchange Bank Buildings.

General News.

THE TELEPHONE.

CHICAGO, ILL.—Application has been made by the Illinois Telegraph and Telephone Company for a permit to begin the construction of tunnels and subways under the streets of the West Side.

INDIANAPOLIS, IND.—The New Long Distance Telephone Company has declared its regular one per cent. quarterly dividend, payable Jan. 1.

CAIRO, IND.—The citizens of this village have formed a co-operative telephone system independent of all other lines in the farming community. J. E. Kolb is president and F. M. Buskirk secretary.

MARION, IND.—The Farmers & Citizens Telephone Company, of Sweetser, has organized and will secure long distance connections through the lines of the Central Union Telephone Company at Marion. The company will build an exchange at Sweetser.

KOKOMO, IND.—The Central Union Telephone Company has reduced its rates considerably and is endeavoring to regain the ground lost to the Citizens' Company. It is claimed that the latter has 1,500 subscribers, as compared with 300 of the Bell Company.

INDIANAPOLIS, IND.—The underground occupancy of the streets of this city has become so congested that the Home Heating & Lighting Company has been restrained at the instance of the Central Union Telephone Company from laying heating pipes close to its conduits. The matter will likely be adjusted satisfactorily.

INDIANAPOLIS, IND.—The growth of the business of the New Telephone Company, at Indianapolis, continues to be remarkable. Ever since the completion of its two new branch exchanges the company is unable to take care of the business coming to it and will be obliged to erect a new building at the rear of its main exchange.

TERRE HAUTE, IND.—The Kinloch Long Distance Telephone Company, of Missouri, has completed its pole line to Terre Haute, and will commence stringing wire at once. It expects to be ready to connect with the New Long Distance Telephone Company, of Indianapolis, at Terre Haute, for through service between Indianapolis and St. Louis, about Feb. 1.

EVANSVILLE, IND.—Judge Baker, of the Federal Court, has issued a temporary restraining order against the city of Evansville from interfering with the rights and property of the Cumberland Telephone & Telegraph Company, of Kentucky. In case the Court refuses to grant a permanent restraining order, or even if it does, it is highly probable the matter will be taken to higher courts. Mayor Covert claims that $100,000 has been subscribed for the municipal telephone plant. He estimates that $175,000 will be needed for its construction, and thinks there will be no trouble in raising the required amount. The Cumberland Telephone Company owns exchanges in seven States and claims to have acquired a perpetual franchise in Evansville in 1882. In 1887 the City Council passed an ordinance limiting its franchise to fifteen years. Last August the Council passed an ordinance rescinding the rights of the company to the streets and notified it to vacate by Dec. 17. The case will come up for a hearing on its merits the first week in April, if not raised sooner by a motion to dissolve the restraining order.

CHICKASHA, I. T.—The Bell Telephone Company and the Chickasha City Council are at war. The Bell Company was here before the city had a charter, but when it asked permission to extend its system, it was refused. Meanwhile a local company was granted a franchise. The Bell Company paid no attention to the Council, but continued to erect and string wires. At the last meeting the Council issued rigid instructions to the marshal, who, on Dec. 24, began chopping down Bell poles, destroying wires all over the town. He did a good job of it, and will continue until the entire local system is wrecked, unless stopped by injunction. The matter will be settled in the courts.

KEOKUK, IA.—Montezuma will vote on January 5 on granting a franchise to the Keokuk, Mahaska and Poweshiek Mutual Telephone Company.

AUBURN, KY.—R. M. Ray is building an independent telephone line from Stowers to Auburn.

FOREST CITY, LA.—The Great Northern Telephone Company has been organized at this place with a capital of $25,000. The intention of the promoters is to build rural and toll lines all over the county.

NEW ORLEANS, LA.—Nine of the men who were engaged in the late telephone strike were convicted of contempt of court in the United States Court in disobeying its injunction and sentenced for long terms.

COKATO, MINN.—The Cokato Telephone Company has been organized here, capital, $10,000. The company will maintain a local exchange and lines around the village.

HARTVILLE, MO.—Prophet & Johnston, owners of the Hartville Telephone Company, with lines to Mansfield, Mountain Grove and Duncan, will put in a central system here at once.

LEWISTOWN, MONT.—The Lewistown Telephone Company is installing a 200-drop switchboard.

HAMILTON, MONT.—The Bitter Root Telephone Company is about to build a line from Hamilton to Hughes Creek, Mont.

FORT BENTON, MONT.—The Benton-Highwood Telephone Company will incorporate here shortly. The members of the company are: A. D. Viddert and J. M. Burlingame, of Great Falls, Mont., and H. E. Robbins, of Fort Benton.

LEBANON, N. J.—The Lebanon Telephone Company, of Lebanon, Hunterdon County, with capital of $5,000, has been incorporated by George Clark, S. J. Shurtis and E. W. Sutton.

JAMESTOWN, N. Y.—The Chatauqua County Telephone & Telegraph Company has been incorporated with a capital of $25,000, to build a line and operate telephone exchanges and systems throughout this county. Directors, T. S. Lane, L. P. Lane, B. D. Phillips, and others.

ITHACA, N. Y.—The Board of Supervisors has decided to grant a contract to the Ithaca Telephone Company to furnish service to the county for one year. An opportunity is also given the Bell Company to share in the contract. The Bell Company offered its service for $165 a year. The Ithaca Telephone Company made a bid of $75.

PERU, OHIO.—The Local Telephone Company, of Norwalk, is planning to establish a branch at Peru.

TOLEDO, OHIO.—The exchange of the Toledo Home Telephone Company has been turned over by the construction company.

GALION, OHIO.—The Galion Telephone Company is preparing to spend about $50,000 in improvements. The exchange is being remodeled.

MANSFIELD, OHIO.—The Federal Telephone Company has authorized the expenditure of $40,000 on improvements in the plant of the Mansfield Telephone Company.

URBANA, OHIO.—The Urbana Telephone Company has elected the following officers: C. H. Marvin, president; J. I. Blose, vice-president; F. J. Brand, secretary; J. C. Powers, treasurer.

LENOX, OHIO.—The Lenox Telephone Company is making numerous improvements and an extension is being built to Sentinel. Connection has been made with the Warren & Jefferson system.

NEWARK, OHIO.—The Newark Independent Telephone Company has placed an order for an addition to its switchboard to accommodate 500 new subscribers. Other improvements will be made.

NORTH BALTIMORE, OHIO.—The North Baltimore Telephone Company is preparing to make numerous improvements and will connect with the long-distance lines of the United States Telephone Company.

NEW PHILADELPHIA, OHIO.—The Tuscarawas Telephone Company has had a most successful year. It now operates six exchanges and has 2,500 subscribers. Improvements are being planned for next year.

TOLEDO, OHIO.—The leading stockholders of the Toledo Home Telephone Company have organized a voting trust and pooled their stock for a period of five years to prevent the purchase of stock by unfriendly interests.

CINCINNATI, OHIO.—The City & Suburban Telegraph Association (Bell) has absorbed the Millcreek Valley Exchange system, heretofore owned by H. M. Grove. The system will be improved and the toll rates to the city reduced.

CLEVELAND, OHIO.—The city is taking steps to compel the Cleveland Telephone Company (Bell) to permit the Cuyahoga Telephone Company to use its poles in certain sections of the city. It is claimed that the Cleveland company has no franchise.

WOOSTER, OHIO.—The M. W. & O. Telephone Company is preparing to make extensive improvements. A new 1,000-drop multiple board has been ordered from the North Electric Company, Cleveland, and new cables and new instruments will be installed.

CLEVELAND, OHIO.—President Dickson, of the Federal Telephone Company and of the United States Telephone Company, has announced that the January interest on the United States and Cuyahoga bonds, together with the defaulted July interest, is to be paid at once.

OBERLIN, OHIO.—The exchange of the Oberlin Telephone Company was almost totally wrecked recently by the trolley of a car jumping the wire and striking the main telephone cable. The switchboard immediately caught fire. The board was ruined and over 150 telephones were burned out. It will be some time before service can be resumed.

CLEVELAND, OHIO.—The statement of the United States Telephone Company for the month of October shows the following results: Gross earnings, $28,555; operating expenses, $15,387; fixed charges, $7,771; surplus, $5,397. The increase over the previous month is considerable, owing to the recent connection of the Michigan lines with the main system.

CHARLESTON, S. C.—Work has been started by the Southern Bell Telephone Company on a $13,000 three-story telephone exchange building.

BETHEL, TENN.—A strong effort will be made to have extended to Bethel the telephone line proposed to be run from Pulaski to Stella and Heron.

RICHMOND, VA.—The Bell Telephone Company announces that it has purchased the Richmond Telephone Company, but will take it over only by full consent of the City Council and with public approval. The purchased company has recently put in an expensive equipment.

GREEN BAY, WIS.—Green Bay business men are considering a plan of organizing an independent telephone company to build an exchange in this city.

GREEN BAY, WIS.—The Wisconsin Telephone Company will construct a long distance line from Sturgeon Bay direct to the end of the county, to connect with the proposed cable across "Death's Door."

LA CROSSE, WIS.—The Wisconsin Telephone Company, after a fight with the local company, the La Crosse Telephone Company, of several years' standing, has decided to raise its rates to those of the independent company.

FOND DU LAC, WIS.—The Little Wolf River Telephone Company is to be reorganized. Its capital stock is to be increased from $125,000, the present amount, by probably $50,000 or $75,000. It will then be placed on a good business basis.

CHEYENNE, WYO.—The Bell Telephone Company will build a new exchange here, the contract having been awarded.

CHEYENNE, WYO.—The Ranch Telephone Company has been incorporated here. It is capitalized at $10,000. The Coal Creek Telephone Company, with a capital of $2,500, has also been incorporated here.

ELECTRIC LIGHT AND POWER.

HUNTSVILLE, ALA.—The city seems determined to build a lighting plant of its own, which, if done, will take away a main support of the electric street railway corporation. The latter threatens to remove its electric railway if the city electric light plant is established. An election will be held on Jan. 19 to vote on $20,000 electric light bonds.

DENVER, COLO.—The Queen City Foundry Company is putting in a plant for arc and incandescent lighting in connection with its new shops.

HARTFORD, CONN.—The New London Gas & Electric Company has asked for approval of an increase of its capital stock from $400,000 to $500,000.

MONTPELIER, IND.—Capitalists are negotiating for the purchase of the Montpelier water and electric light plant.

ALEXANDRIA, IND.—The electric lighting contract for this city will expire in February, and the present company will not renew it at present rates, as the cost of fuel is too high.

SOUTH BEND, IND.—Over $1,000,000 is to be expended in the construction of a water-power electric plant on the St. Joseph River near South Bend. It is stated that nearly 10,000-hp. is available.

RICHMOND, IND.—The municipal electric light plant, of this city, which has cause so much trouble in the past, is still a great source of annoyance to the city administration. The Council has named a committee to confer with the Electric Light Commission, which has full control, regarding the management.

KOKOMO, IND.—Five franchises are asked from the City Council, the petitioners being George J. Marott, of Indianapolis, and George F. McCulloch, of Anderson. Mr. Marott wants a 30-year extension of his electric street railway and electric lighting plant franchises, and Mr. McCulloch asks for a 30-year franchise for an electric lighting system and certain concessions for his interurban line, for which the city already granted a franchise.

DULUTH, MINN.—The Mesaba Light & Power Company has filed articles of incorporation. The company proposes to furnish light and power for Virginia, Minn., and is capitalized at $25,000. The limit of indebtedness is also $25,000. The incorporators are John Costin, Jr., and John D. Lamont, of Virginia, and Daniel D. Crowley, of Duluth.

HAMLET, N. C.—The Hamlet Electric Light Company, capital $100,000, has been chartered. G. O. Sanders is interested.

ARLINGTON, OHIO.—Charles Cotner, of the Arlington light plant, is planning to establish a plant at Mt. Blanchard.

COLUMBUS, OHIO.—The sinking fund trustees have accepted $110,000 electric light bonds which will make possible the erection of the long-talked-of municipal plant.

GRAND RAPIDS, OHIO.—Augustine Pilliod has completed a private electric light plant and has secured a contract to illuminate the village. He will furnish fifteen arc lamps.

MARION, S. C.—The Marion Water, Light & Power Company has been commissioned, with a capital stock of $100,000. Arthur Dunn and A. N. Walker, of Scranton, Pa., and J. W. Johnson, of Marion, are the corporators.

LAWRENCEBURG, TENN.—Granbury Jackson, of Mt. Pleasant, Tenn., has prepared for the city estimates on a combined water and light plant. A dynamo of 50-kw. capacity is provided for. The total cost will be over $20,000. Bonds will probably be issued by the town to pay for the plant.

MORGANTOWN, W. VA.—The Morgantown Electric Lighting & Traction Company has let the contract for the building of its new power house.

THE ELECTRIC RAILWAY.

HARTFORD, CONN.—These petitions for charters for electric railways have been filed: Through Naugatuck, Beacon Falls and Seymour; incorporators, George A. Lewis, J. H. Dayton and A. D. Warren. Through Branford Point, Pine Orchard, Stoney Creek, to Guilford; by the Branford Lighting & Water Company. Through North Haven, Wallingford, Meriden and Berlin; by the Meriden Electric Railway Company.

WARSAW, IND.—The Huntington & Winona Traction Company has been granted a franchise through Kosciosko County.

INDIANAPOLIS, IND.—The Wabash River Traction Company has placed contracts for two sub-stations between Peru and Logansport. L. W. Law is general manager of the company.

EATON, IND.—The general offices of the Muncie, Hartford & Ft. Wayne Traction Company have been removed from Muncie to Eaton, where the power house and office building is about completed. The completion of the road has been held up through the inability of the bridge company to furnish bridges on time. It is expected cars will be in operation early next year. The road is owned by Cleveland people, headed by S. M. Hexter and J. C. Gilchrist.

TOPEKA, KAN.—The Topeka, Lawrence & Kansas City Electric Railway Company, capital stock $2,000,000, has been incorporated by J. B. Adams, H. M. Levan, R. Levan, T. S. Salathiel, M. L. Adams and E. R. Salathiel.

LOUISVILLE, KY.—Chief Engineer Jeup, of Indianapolis, has commenced surveys for the New Albany, Paoli & French Lick Valley Traction Company's line.

MIDDLEBORO, MASS.—Articles of association have been signed for the formation of the new Sandwich, Hyannis & Chatham Street Railway Company, which is to extend the Middleboro, Wareham and Buzzard's Bay trolley system into the heart of Cape Cod. The new line will be 45 miles long, extending from Sandwich station to a point near Chatham light.

LANSING, MICH.—The Michigan Central Traction Company has been granted a franchise through town. The road must be completed in the city by June 1, 1903.

DETROIT, MICH.—The Detroit, Monroe & Toledo Short Line has been incorporated with $3,000,000 capital stock to take over the Toledo & Monroe Railway and build the long-talked-of extension from Monroe to Detroit. The company has secured a right of way which will afford much shorter time into Detroit than the old route through Trenton. Of the capital, $1,000,000 will be set aside for double tracking the line later. While it is now hardly probable that the line will be acquired by the Detroit United Railway, there is strong probability that the Everett-Moore syndicate will perfect traffic arrangements for the through operation of cars from Cleveland to Detroit.

OMAHA, NEB.—A street railway consolidation has been effected here by turning the old Omaha & Florence Street Railway Company into the Omaha & Council Bluffs Street Railway Company. The capital stock of the latter was increased from $200,000 to $15,000,000. The entire project is being financed by J. & W. Seligman, of New York, who recently purchased the Omaha road.

NEW YORK, N. Y.—Mayor Low has signed the New York & Jersey tunnel franchise for the new Hudson River tunnel, which is to be operated by electricity.

LIMA, OHIO.—The Lima Electric Railway & Light Company has sold its old power plant to a company headed by Walter Parmenter.

ZANESVILLE, OHIO.—The Zanesville Railway, Light & Power Company has decided on plans for a large power station to be erected on the Muskingum River in this city.

XENIA, OHIO.—It is announced that the Xenia & Wilmington Traction Company has secured all the required right of way and that construction work on the line will start in the spring.

DELTA, OHIO.—The Toledo & Indiana Railway Company has completed arrangements with the Delta Electric Light Company to build an extension to its power house to supply current for a portion of the railway.

COLUMBUS, OHIO.—The Scioto Valley Traction Company is placing contracts for the material required in equipping the road. The power station will be erected near Reese's Station. The cars will be 60 feet in length and will be capable of a speed of 60 miles an hour.

MARIETTA, OHIO.—The Parkersburg, Marietta & Interurban Railway Company is installing a telephone dispatching system on its line. Cars will be operated through from Marietta to Parkersburg.

CLEVELAND, OHIO.—E. P. Roberts & Company, Cleveland engineers, are closing contracts for the equipment of the Dayton & Muncie Traction Company, the company which is building a northern extension of the Dayton & Northern Traction Company. A large power station will be erected.

CLEVELAND, OHIO.—The Cleveland, Elyria & Western Railway Company has closed a contract with the government to handle the mail between Oberlin, Birmingham, Florence, Berlin Heights, Berlinville and East Norwalk. Heretofore this has been handled by the Lake Shore (steam).

CLEVELAND, OHIO.—The recent snow storm tied up nearly all the interurban lines and many of the city lines of Northern Ohio. The Lake Shore Electric Railway succeeded in running one car through from Toledo to Cleveland. The other Toledo and Cleveland lines were in equally bad condition. Much of the trouble was caused by snow drifts at undergrade crossings.

WASHINGTON, C. H., OHIO.—Local people are planning to build an electric railway from Marysville, Ky., to this point to connect with a line to Columbus. The road will be known as the Columbus & Marysville Railway and will touch Ripley, Georgetown, Sardinia, Hillsboro and Washington, C. H. Residents along the route are being asked to raise 10 per cent of the cost of construction.

CLEVELAND, OHIO.—For the first time since President Andrews took charge of the Cleveland Electric Railway Company has an inkling been given as to the earnings of the company. It is stated that on November the receipts were $214,993, a gain of $25,552 over the corresponding month last year. For eleven months the receipts were $2,284,335, as against $2,077,012, an average gain of $10,000 a month.

CLEVELAND, OHIO.—Details of the consolidation of the Cleveland, Elyria & Western Railway with the Cleveland & Southern and the Norwalk Gas & Electric Company have been completed. The new company will probably be known as the Cleveland & Southwestern Railway. The capital stock will be $5,000,000 and as the three properties have a combined capitalization of much less than this amount, it would appear that a portion of the issue will be retained for the purchase of the Cleveland, Ashland & Mansfield and the Ohio Central Traction Company when the system is connected. Two millions of this capitalization will be preferred and the balance common stock. For the present the bond issue will be $2,100,000 covering the underlying issues of the three properties.

CLEVELAND, OHIO.—The Lorain & Eastern Railway Company has been incorporated with temporary capital stock of $1,000 by A. D. Stuber, Wm. D. Young, George L. Cooley, D. T. Miller, Frank R. Lander and Henry W. Stecker. The promoters propose to build a new line from Rocky River to Elyria and Lorain. The line would parallel and be between the Cleveland, Elyria & Western and Lake Shore Electric roads. While it would touch several towns not reached by either of the roads, it is difficult to see how it can be made to pay in competition with two strong lines. It is claimed the company will have its own private right of way the entire distance and that the running time to both Elyria and Lorain can be reduced twenty minutes. A similar project originated about a year ago, but nothing has been heard of it for some time.

NEW INDUSTRIAL COMPANIES.

THE AMERICAN DE FOREST WIRELESS TELEGRAPH COMPANY has been incorporated at Kittery, Me., with a capital of $5,000,000. Hiram Thomson is president and R. A. Jordan treasurer.

THE TURBINE ELECTRIC TRUCK COMPANY, of Yonkers, N. Y., has been incorporated; capital, $100,000. Directors—J. D. Sullivan and H. D. Crippen, New York; F. A. Curtiss, Nutley, N. J.

THE DUNKIRK POWER & HEATING COMPANY, of Dunkirk, N. Y., has been incorporated with a capital of $50,000. Directors—A. W. Cummings, Harry Durrell, and H. T. Litchfield, Dunkirk.

THE YOST ELECTRIC MANUFACTURING COMPANY, of Toledo, Ohio, has been incorporated with a capital of $75,000. The incorporators are: C. A. Morris, John Renner, J. Stollby, J. Bours and Louis Mandler, all of Toledo.

THE PAN-ELECTRIC SERVICE & APPLIANCE CO. has been incorporated at St. Louis, with a capital stock of $7,000. H. S. Graber, P. I. Chandeysson, W. H. Schiveder, D. F. Babcock and O. L. Wait are the shareholders.

THE ELECTRIC ALUMINUM PURIFYING COMPANY has been incorporated at Kittery, Me., to make and sell machines for purifying water. The capital is $500,000. Charles C. Smith is president and C. M. Prince treasurer, both of Kittery.

THE INDIANA COMPANY, with a capital of $1,000,000, has been incorporated in New Jersey. It will construct railways and electric light plants in Indiana. The incorporators are Thos. Dolan, Randall Morgan, F. H. MacMorris, C. N. Latourette and George H. Martin.

THE HERCULES ELECTRIC & MANUFACTURING COMPANY, of Indianapolis, Ind., has incorporated, with a capital of $10,000. The company will manufacture electric generators, machinery and other electrical appliances. John A. Kurtz heads the board of directors.

OBITUARY.

PROF. FRANCIS FOWLER, a principal examiner in the Patent Office, and one of the oldest employees in the Government service, died at his home in Washington last week. Mr. Fowler entered the service in 1869 from western New York, and rose to the grade of principal examiner in 1876. He had charge of the division of steam appliances, and was well known to many inventors in the mechanical and electrical field.

MR. J. J. DICKEY.—John J. Dickey, Superintendent of the fifth district of the central division of the Western Union Telegraph Company, and one of the oldest officials in the service of that corporation, died at his home in Omaha, Neb., on Dec. 29, of pneumonia. He was born in Rushville, Ill., April 11, 1839. In 1857 he entered the law office of Judge J. D. Caton, of Chicago, where he also learned telegraphy. He was identified with a number of the telegraph companies, and served during the war as a military telegrapher. He then entered the service of one of the largest companies, which later merged into the Western Union, with which concern he has held an official position for twenty-five years. He was a promoter of the first telephone company, and at the time of his death was a director and Vice-President of the Nebraska Telephone Company and Vice-President of the American District Telegraph Company. He also was identified with financial institutions of Omaha, and was an extensive owner of real estate there.

PERSONAL.

JOHN A. STEWART.

MR. JOHN A. STEWART, well-known as a pioneer in electrical commercial development, has recently taken some important steps on his own behalf. He is now located at 430 Sycamore Street, Cincinnati, O., where he is conducting the John A. Stewart Electrical Company, with factory and warehouses at Ludlow, Ky. Mr. Stewart has been engaged in the electrical business for some fifteen years with the General Electric, Bullock, and Rossiter-MacGovern interests. He severed his connection recently with the concern last named in order to establish his new organization to deal in steam and generating plant of all kinds, motors, etc., and to carry on incidentally a repair department. The Tucker-Anthony Company, of Cincinnati; the St. Louis Transit Company; the Cincinnati & Indianapolis Street Railway, etc., have already made arrangements with him to handle apparatus from their respective power plants. Mr. Stewart has recently leased an extensive factory occupied formerly by the firm of Post & Company, of Ludlow, Ky., for warehouse purposes, and where he will engage also in manufacturing commutators and various supply parts of electrical apparatus. Mr. Stewart not only enjoys a wide acquaintance in the field, but a long and varied experience with all classes of electrical machinery.

MR. WALTER C. FISH, of the General Electric Company, of Lynn, Mass., has been elected a director in the Fore River Ship & Engine Company.

PROF. A. G. BELL is again arresting attention with his work on airships and his kite aeroplanes have lately been the subject of various articles in the newspapers.

MR. A. E. LANG has retired from the presidency of the Toledo Railways and Light Company, of Toledo, Ohio, and turned the office over to his successor, Mr. E. W. Everett, who represents the Everett-Moore Syndicate.

PROF. MORGAN BROOKS, of the Department of Electricity of the University of Illinois, has been visiting New York during the Christmas vacation and is now in New England on personal business.

MR. FRED. A. GEIER, the well-known treasurer of the Cincinnati Milling Machine Company, has an interesting article in *American Industries* on the development of internal waterways as a national movement as related to the National Association of Manufacturers.

MR. G. M. GEST, the conduit contractor, has been awarded the additional contract in Dayton, Ohio, by the Oakwood Street Railway Company and the People's Street Railway Company for the reconstruction of their tracks in that city. This contract amounts to approximately $15,000.

MR. J. I. MATTHIAS, of Camden, S. C., southern representative for Rumsey Electrical Manufacturers' Company, of Philadelphia, has secured a franchise from the town of Cheraw, S. C., for lighting that town. The "proposition," although small, is said to be one of the best in the South.

MR. J. B. ORR, of the electrical engineering and contracting firm of James Mitchell & Co., of Rio Janeiro and San Paolo, Brazil, which represents the interests in that part of the world of the General Electric Company and other prominent American concerns, is expected to arrive in New York about Jan. 15.

MR. J. B. CAHOON, the secretary of the National Electric Light Association, has recently returned to New York City from a long trip out through the Pacific Coast on expert work. He reports the affairs of the Association in a most flourishing condition, with accessions of membership from all over the country.

MR. JOHN M. MACK has resigned from the board of directors of the Philadelphia Electric Company, the resignation to take effect Jan. 1. Rumor connects Mr. Mack's resignation with the recent striking out by councils committee of the clause in the Keystone ordinance allowing the company to use their conduits.

MR. Y. NOGAMI, the engineer of the Tokio Electric Light Company, which concern operates the largest lighting plant—4,200-hp.—in that part of the world, sailed for Europe Saturday after a visit of some three months' duration on this side, during which time he inspected several of the large power plants throughout the country.

MR. CARL SCHWARTZ, formerly of Siemens & Halske, in Germany, has joined the engineering staff of the Chicago Edison Company, at Chicago, where his services are valuable because of his intimate knowledge of European electric lighting practice. Mr. Schwartz has already made many friends also in New York City.

MR. W. JAC MARLAND, general agent of the Brooklyn N. Y. Edison Company was very agreeably surprised at Christmas time by receiving from the members of his staff a handsome and beautifully finished clock, as a mark of their appreciation of his manly qualities and the good feeling toward him of all working under him. Mr. Marland is making a great success of his work in Brooklyn, developing the patronage given the company.

MR. S. L. BARRIETT, of the Cincinnati Electric Motor Company, has been visiting New York during the Christmas holidays. He has many friends in the city who have watched with interest his development of motor production further west. Mr. Barriett has long been known in the motor field, and is now building from his own designs motors from ½ up to 10 hp.

MR. MANNING K. EYRE has been elected president of the Buckeye Electric Company, of Cleveland, Ohio, to which position he advanced from that of general sales manager of the same company. Mr. Eyre has been identified with the incandescent lamp industry for the past ten years, having started in the Edison Lamp Works, of which, several years later, he became manager.

MR. H. H. SUPLEE, editor of the *Engineering Magazine*, has an interesting résumé of the quarter's progress in "Applied Science" in the January-March *Forum*. He notes especially how the standardization of methods of manufacture and the discouragement of the demand for special articles have contributed to make the work of modern engineering of a much more wholesale character than formerly.

MR. ANDREW CARNEGIE has notified the Provost of Greenock, Scotland, that he is prepared to give $50,000 to erect a memorial to James Watt, the inventor, who was born in that city on Jan. 19, 1736, in recognition of his engineering achievements; or he will head a movement in America to raise a large fund which, in conjunction with sums raised in Great Britain, will provide for a more extensive scheme of commemoration.

MR. PHILIP DAWSON.—In our issue of Nov. 1 we gave an account of the interesting plans for the big power plant and transmission of the Midland Power Co., England. We learn that Mr. Philip Dawson and his associates in the firm of Kincaid, Waller, Manville & Dawson, of London, were the engineers who designed the complete installation, supervised the construction, and are responsible for the sucessful completion of the plant.

SIR HIRAM MAXIM will leave England for America, where he expects to remain about two years. Sir Hiram explained to a newspaper representative that he had a twofold object in making a long stay in America. In the first place he hopes to cure a troublesome throat complaint, and, secondly, he intends to carry out an important series of experiments with a view to building a flying machine somewhere along the coast of Connecticut. He has already done some important work in this field.

MR. RAMON VALDES, of 44 Broad Street, New York, has returned from a trip to Porto Rico, where he recently went in the interest of the Rio Plata Electric Company, which proposes to build a dam and power house in the Rio Plata, located in the mountains about 17 miles distant from the city of San Juan, and which also contemplates the conversion of the existing narrow gauge steam road running between Catano and Bayemon, a distance of about four and one-third miles, into a broad gauge electric traction system. George W. C. Drexel is president of the company.

MR. G. WESTINGHOUSE.—An interesting cable dispatch from London, of Dec. 27, says: George Westinghouse is here now taking things easy at his hotel for the holidays after two months of hard work. There is no busier man in London than this great engineer. At 7 o'clock in the morning he is out to his city office—three hours before the leisurely English capitalists think of starting to work—and often before that hour he is speeding to Manchester to see to his enormous establishment there, which is quite as large and important as his Pittsburg house. Mr. Westinghouse takes no recreation in London. He hardly ever

goes to the theatre, and no one has ever seen him at a race meeting. His work is his life. Every railway train in the United Kingdom is fitted now with his air brake. He will return to Pittsburg early in February.

STROMBERG-CARLSON BANQUET.—On the evening of Dec. 12, the Stromberg-Carlson Telephone Manufacturing Company, of Chicago, Ill., and Rochester, N. Y., gave a banquet at the Great Northern Hotel, Chicago, at which the following men were present: Alfred Stromberg, T. R. Finucane, C. W. Stiger, A. J. Rousseau, H. G. Webster, A. Hulbrich, Eugene L. Brown, F. L. Martin, William Bowen, F. L. Middleton, R. B. Tyler, E. C. Lewis, H. B. Hewitt, H. D. Eddy, L. R. Krum, C. E. Knickerbocker, A. S. Munsell, G. A. Muir, Paul D. Meyers, G. H. Pierce, B. B. Willis, H. L. DuPont, G. L. Burlingame, C. H. Hague. The banquet was given largely to enable the men to meet each other, also to explain to the salesmen the use of a new book of "Standard Switchboard Specifications," which the company has recently gotten out. This has been pronounced by many prominent telephone men, who have seen the book, as one of the most complete treatises on telephone switchboards that they have ever seen. It will, no doubt, help to standardize all the apparatus manufactured by the independent companies, as well as to maintain their own standards. Following the banquet and preceding the explanation of the above book, Mr. Bowen, the company's Iowa representative, in behalf of the salesmen, presented Messrs. C. W. Stiger and F. L. Middleton each with a scarf pin with diamond setting. Following the presentation, Messrs. Stiger and Middleton responded in a fitting manner, thanking the gentlemen for the token of their appreciation, also for the efficient service rendered. Following the above, general remarks were made by Messrs. Finucane, Stromberg, Middleton, Bowen, Brown, Rousseau, Stiger, Martin, Tyler, Meyers, Lewis, Smith, Munsell and Pierce. At the close of the banquet a flashlight picture was taken of the members present.

EDUCATIONAL.

UNIVERSITY OF ILLINOIS.—There has recently been received the last shipment of the new generator set for the power plant of the University of Illinois. This combined engine and generator set consists of a 200-hp. compound Westinghouse engine and a 150-kw. Westinghouse generator, with revolving field. This new equipment has been made necessary by the recent increase in the number of buildings at the University.

THE MANSFIELD TECHNICAL SOCIETY, of Mansfield, Ohio, has been organized among the officers and employees of the Ohio Brass Company, of that city. The object of the society is the promotion of technical knowledge among its members. The regular meetings of the society are held on every third Tuesday, at which time papers pertaining to various branches of technical work are read and discussed. A reading and reference library has been established in connection with the society, and a number of technical papers, trade journals, etc., are kept on file for the use of the members. Any contributions in the way of the scientific or trade papers will be thankfully received.

Trade Notes.

NEW AUTOMOBILE FACTORY.—A $1,000,000 automobile factory will be built at Atlanta, Ga., to be known as the De Loach Varispeed Company. A. A. De Loach and others are interested. A charter has been applied for.

THE D. M. STEWARD MFG. CO., of Chattanooga, Tenn., manufacturers of Lavite, the well-known insulation, will remove its New York offices Jan. 1st, from 107 Chambers St., to 8 Jay St.

THE TELEPHONE DEPARTMENT of the Electric Appliance Company, Chicago, has been improving the celebrated Noxem receiver until it feels warranted in claiming that it is a perfect receiver. It follows this statement with the one that it has never put a telephone specialty upon the market which has met with the wonderful success that has been accorded to the Noxem receiver.

STERLING VARNISH COMPANY, of Pittsburg, Pa., reports that its European address is Brougham Street, Blackfriars Road, Salford, Manchester, England, where all communications as to its foreign business should be addressed hereafter.

BULLOCK ELECTRIC MANUFACTURING COMPANY, of Cincinnati, has just issued for 1903 another charming series of illuminated portrait calendars, the portraits being those of well-known scientists and engineers. We are glad to note in the series the portrait of the company's chief engineer, Mr. B. A. Behrend, of whom an illustrated biography appeared in these columns, July 6, 1901.

MESSRS. H. B. COHO & CO., contracting engineers, 114 Liberty Street, New York, have issued a neat booklet telling briefly what they have done, what they are doing and what they can do. Ilustrations show various buildings, institutions, etc., equipped by this firm, and they show a varied class of equipment. The firm's work embraces steam, hydraulic and electrical engineering, and it has been engaged in these lines for the past ten years.

THE OSBURN FLEXIBLE CONDUIT COMPANY has found the demand for Flexduct so much greater than it had anticipated that it has been obliged to increase its facilities for manufacturing it. It has just completed a new factory in Hoboken, N. J., adjoining the old one, which gives it about one-third greater capacity than before. Mr. Corrigan, the vice-president and general manager of the company, reports that the sales have been increasing tremendously and that Flexduct is now in use all over the country, besides which considerable quantities have been shipped to South Africa and the various European countries.

THE AMERICAN MINIATURE & DECORATIVE LAMP COMPANY, of New York City, will move Feb. 1 from 436-438 Broome Street to new quarters at the corner of Hudson, Spring and Vandam Streets. The new location affords much larger quarters than the old one, the space being about five times greater than that which is now occupied. The company has had a wonderful record since it started, the present removal being the fourth which it has made in the past four years, each time to larger quarters; while it is the second increase made in one year alone. The company manufactures a very fine line of miniature lamps of all shapes and for all purposes.

THE ELBLIGHT COMPANY OF PITTSBURG, Pittsburg, Pa., has recently issued a pamphlet descriptive of the Elblight system of electric lighting. As is well known, this system comprises a form of cable for decorative lighting and boards for sign and similar work. A lamp becomes lighted, no matter where it is placed along the cable or on the board. The simple operation of sticking it into place is all that is necessary. This system of lighting has been a conspicuous feature at many important gatherings, some of which decorations have been illustrated in ELECTRICAL WORLD AND ENGINEER during the past year. The pamphlet is illustrated with views of ball-rooms, banquet halls, exteriors, etc., decorated and illuminated by means of this system. There is no limit to its application.

COUCH & SEELEY COMPANY, Boston, Mass., announces that on Dec. 15 an arrangement was concluded whereby the Haines & Noyes Company, 153 South Jefferson Street, Chicago, Ill., become the Western Department of the former company. Commencing Jan. 1, Mr. N. H. Holland, formerly in the employ of the Holtzer-Cabot Electric Company, and more lately consulting engineer for the Automatic Telephone Meter Company and the Holmes-Mayberry Company, will become associated with the Couch & Seeley Company. Mr. Holland's technical knowledge and experience in telephone matters cannot fail to make him a valuable assistant in the executive department of this company. The Couch & Seeley Company is much gratified at the large increase in the volume of business being handled. It is making a full line of exchange apparatus, including both central energy and magneto call equipment, a complete line of interior inter-communicating apparatus, and a line of telephones especially adapted to street railway and police service.

THE CHLORIDE STORAGE BATTERY IN EDISON STATIONS.—The Electric Storage Battery Company, of Philadelphia, has just completed the largest year's business in its history and a notably large amount of the orders closed are for installations for Edison stations. The New York Edison Company has just contracted for eight new batteries of its standard unit size, each having a capacity of 8,000 ampere-hours. With the thirteen installations already in service this makes twenty-one chloride batteries, having a total capacity of 176,000 ampere-hours operated by the New York Edison Company. This is the largest amount of storage battery operated by any one company in the world. The Chicago Edison Company has also recently added three new batteries to its system and have increased the capacity of its other batteries, making ten installations with an aggregate capacity of 108,000 ampere-hours. The Brooklyn Edison Company recently added two new batteries to the six already in service, each consisting of 8,000 ampere-hour capacity, making a total battery capacity for this company of 51,000 ampere-hours.

SHOW CASE LIGHTING is a subject that appeals to every merchant who desires the interior displays of his goods to accord with the impression his customers receive from well-lighted windows and other advertising. With the realization of the need for this form of lighting comes the natural questions as to methods for producing best results. I. P. Frink, manufacturer of reflectors, 551 Pearl Street, New York, has been especially successful in this line of work, as the numerous large contracts will testify. Among these might be mentioned: Simpson, Crawford Co., R. H. Macy & Co., John Wanamaker, Lord & Taylor, New York City; Gimbel Bros. and N. Snellenburg & Co., Philadelphia; Panton & White, Silberstein & Bondy, Duluth; Hahne & Co., Newark, N. J.; Abraham & Straus, Brooklyn. It is but natural these stores should adopt Frink reflectors for their case lighting, as they had all shared in the success of "The Great Window Light," and those with art galleries used the same system for the artificial lighting thereof. Many merchants who have been convinced of their need of improved lighting for floor and wall cases have put the matter off until the holiday rush was over. This month affords a convenient season for installing fixtures, and goods brilliantly lighted will attract a trade to whom suggestion is necessary. Electrical engineers and contractors would do well to recommend these devices, as the Frink people are always willing to suggest the right reflector for results desired, and to quote prices on application.

DOUBLEDAY-HILL ELECTRIC COMPANY'S NEW BUILDING.—After Jan. 1st, the Doubleday-Hill Electric Company, of Pittsburg, will occupy its spacious new building, 919 Liberty Avenue, Pittsburg. Its large and rapidly increasing business has made more commodious quarters imperative, and some idea of the facilities now at its disposal can be gained from the fact that the new building measures 23x116 and is eight stories in height, besides the basement. This is said to be the tallest building in the world devoted exclusively to electrical supplies. The salesroom and sales offices are located on the first floor where every up-to-date convenience for the display of goods and transaction of business is offered to customers. Immediately in the rear is the receiving and shipping room. The second floor is devoted largely to the general offices of the company, including the auditing and purchasing departments, lockers for the employees, etc. A large quantity of overhead material will also be stored in this floor. The sides of the third floor are lined with bins extending from floor to ceiling, as well as a double row of bins down the center. These contain broken packages of porcelain, incandescent lamps, switches, etc. The assembling room for orders is conveniently located close at hand. The fourth floor affords facilities for storing rubber covered and weather proof wire in quantities, also bins for glassware and shades. Lamps of all kinds in unbroken packages fill up the fifth floor. Prominent among these, of course, are the A.-B. arc lamps and Nernst lamps. Large supplies of Packard and Peerless incandescents are always on hand. The sixth and seventh floors contain original packages of sockets, switches, receptacles, tubes, etc., and conduit and moulding. Battery supplies and fans (including "The Emerson") are also kept here. The entire eighth story is given over to the repair and rewinding department. The amount of work entrusted to this department has steadily increased since its establishment and the new facilities placed at its disposal in the way of improved machinery and conveniences promise well for the future. In the basement is located a generating plant for supplying the building with light and power. This consists of a 25-hp double cylinder gas engine connected to a 12½-kw generator. Cross arms, pine brackets and galvanized wire are stored here also. All goods are received and shipped at the rear of the building—a large freight elevator affording communication between the different floors.

Record of Electrical Patents.

UNITED STATES PATENTS ISSUED DECEMBER 23, 1902.

[Conducted by Wm. A. Rosenbaum, Patent Attorney, 140 Nassau St., N. Y.]

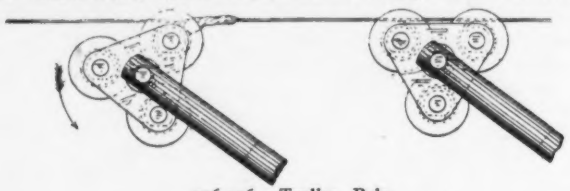
716,362. TROLLEY; W. L. Baker, Painesville, O. App. filed Sept. 29, 1902. The trolley wheel is confined in the fork between springs in a manner to permit it to tilt laterally.

716,365. ELECTRICAL COOKING RANGE AND BROILER; M. Bayno, Cedarhurst, N. Y. App. filed Dec. 31, 1901. The heating resistances are of special character and arranged vertically in two planes, so that a broiler can be inserted between them in a position to apply the heat to both sides of the material being cooked simultaneously.

716,366. ELECTRICAL COOKING APPARATUS; M. Bayno, Cedarhurst, N. Y. App. filed Feb. 19, 1902. A modification of the preceding invention.

716,372. INDUCTION ALTERNATE-CURRENT METER; Otto Titus Blathy, Budapest, Austria-Hungary. App. filed March 20, 1902. An electric meter of the induction type, with a rotating disk between an upper and lower magnetic core; the upper core is V-shaped and carries the voltage coils; the lower and opposing core is E-shaped and carries the current coil on the central stem, the other two stems being opposite the legs of the V.

716,376. TROLLEY POLE; T. C. Buder, St. Louis, Mo. App. filed Dec. 18, 1901. Three trolley wheels are mounted in a triangular frame pivoted in the



716,376.—Trolley Pole.

harp. If one wheel strikes an obstruction on the wire the frame swings to bring another into position upon the wire and thus avoid derailing the trolley.

716,398. FUSE; W. L. R. Emmet, Schenectady, N. Y. App. filed Aug. 24, 1898. The fuse is mounted under tension in a chamber of such construction that the arc is ruptured before the ends of the fuse are entirely withdrawn from the chamber

716,406. ELECTRICAL SWITCH; A. H. Gibbings, Liverpool, Eng. App. filed Dec. 3, 1901. Details.

716,411. ELECTRIC TRAM AND RAILWAY; R. Hacking, Nottingham, Eng. App. filed Dec. 13, 1901. Details of a system whereby current is successively applied to the sections of a supply conductor by the passage of the vehicle.

716,429. COMPENSATING SYSTEM; J. F. Kelly, Pittsfield, Mass. App. filed August 1, 1901. (See Current News and Notes.)

716,445. MEANS FOR REGULATING AND PROTECTING ELECTRIC MOTORS; R. Lundell, New York, N. Y. App. filed Sept. 20, 1902. Means for automatically adjusting the field strength of the motor at the time the armature circuits are changed from series to parallel or from parallel to series, and for preventing an undue rush of current at the time such changes are made.

716,460. MULTIPLE SWITCHBOARD; W. E. McCormick, Chicago, Ill. App. filed Aug. 26, 1901. (See page 33.)

716,475. EXTINGUISHING ELECTRIC ARCS; R. H. Read, Schenectady, N. Y. App. filed April 3, 1901. (See Current News and Notes.)

716,477. TROLLEY GUARD; P. M. Reed, Paterson, N. J. App. filed Oct. 24, 1902. A split pulley is mounted above the main wheel and runs above the wire; its parts are carried on two outwardly-opening spring arms which have sufficient tension to keep the trolley in place, but will open when required to remove the trolley.

716,487. SOCKET FOR INCANDESCENT LAMPS; A. P. Seymour, Syracuse, N. Y. App. filed Feb. 4, 1902. Details

716,506. ELECTRIC SWITCH; G. H. Whittingham, New York, N. Y. App. filed Jan. 21, 1902. A switch whereby when the connection with the main circuit is broken at one side of the switch for stopping or reversing the motor, the armature and field will remain closed and will not be opened except when the motor circuit contact blades are about to enter the main terminals on the opposite side of the switch; this gives the armature time to slow down before the armature and field circuit are broken, thereby avoiding arcing.

716,540. SWITCHING APPARATUS FOR ALTERNATING CURRENT; E. M. Hewlett, Schenectady, N. Y. App. filed Nov. 21, 1900. The combination of an alternating current circuit, of a high potential circuit breaker therefor, an electric control circuit for the circuit breaker, devices responsive to overload in the system governing said control circuit, and a relay also governing said circuit, having one member responsive to line current and the other to line potential.

716,559. DEPOSITION OF METALS ON EARTHENWARE ARTICLES; G. W. Laybourn, Stoke-upon-Trent, Eng. App. filed June 17, 1902. Consists in steeping the article in water, applying to it an electrical conducting medium and then depositing the metal on the article by electrolysis.

716,562. RAILWAY SIGNALING SYSTEM; W. Locke, Troy, N. Y. App. filed Feb. 26, 1902. An arrangement of track circuits and apparatus in a block signalling system.

716,578. ELECTRIC LAMP SOCKET; C. D. Platt, Bridgeport, Conn. App. filed Aug. 20, 1901. A pull-socket having a rotary ratchet and circuit controller.

716,583. CURRENT INTERRUPTER; William Scheidel, Chicago, Ill. App. filed Aug. 29, 1902. An electrolytic current interrupter of the Wehnelt form with improvements designed to prevent frothing of the electrolyte and permitting ready adjustment.

716,584. CURRENT INTERRUPTER; Carl Oscar Schneider, Chicago, Ill. App. filed June 14, 1902. An electrolytic interrupter of the Wehnelt type with means for maintaining a uniform area of exposure of the anode surface, and varying the same at will.

716,643. JUNCTION BOX; C. G. M. Miller, Newton, Mass. App. filed March 2, 1901. The knock-out diaphragms are formed by making opposing depressions in the wall of the box.

716,649. CIRCUIT BREAKER; E. A. Stevens, Chicago, Ill. App. filed July 19, 1901. Details.

716,653. BALANCED-CIRCUIT INDUCTION COIL; J. P. Alexander, Jackson, Tenn. App. filed March 21, 1898. (See Current News and Notes.)

716,654. CABLE HANGER; P. H. Auxer, Cleveland, O. App. filed May 28, 1902. Details.

716,656. ELECTRIC BATTERY COMPOUND; G. Bastedo, Brooklyn, N. Y. App. filed May 28, 1902. Dilute sulphuric acid, 15 pounds; nitric acid, 50 drams, and bisulphate of mercury, 1 ounce.

716,663. PROCESS OF PREPARING STORAGE BATTERY PLATES; R. C. Browne, and F. Balch, Salem, Mass. App. filed April 21, 1902. The raw plates are steeped in a solution made by adding potassium nitrate to heated sulphuric acid and cooler water added to the latter.

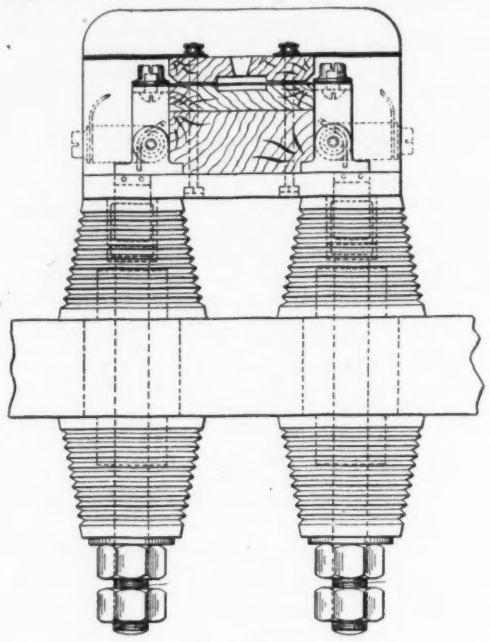
716,762. ELECTRIC BATTERY; G. Rosset, Paris, France. App. filed Feb. 20, 1901. Cupric acid is used as the depolarizing agent.

716,771. MULTIPLEX TELEGRAPHY; H. Shoemaker, Philadelphia, Pa. App. filed Feb. 25, 1901. The invention involves various features of construction affording synchronous movements to all parts along the line and an automatic correcting device in each station.

716,779. TELEPHONE TRANSMITTER CIRCUIT; A. B. Stetson, Malden, Mass. App. filed June 6, 1902. (See page 33.)

716,789. MANUFACTURING CHLORATES; Richard Threlfall, Birmingham, England. App. filed May 2, 1902. The electrolyte is subjected to unequal electrolytic action at the anode and main cathode, the action of the anode being greater; the excess of current is diverted to a subsidiary vessel producing therein an alkaline solution and at the same time a corresponding amount of chlorine in the main electrolyte.

716,801. ELECTRIC BELL; F. W. Wood, Newport News, Va. App. filed Sept. 2, 1902. The hammer actuating mechanism is inclosed in a watertight casing.



716,398.—Fuse.

716,802. TELEPHONE SYSTEM; W. C. Wright, Amarillo, Tex. App. filed Jan. 29, 1902. (See page 33.)

716,804. APPARATUS FOR PRODUCING CAUSTIC SODA BY ELECTROLYSIS; Edward A. Allen, Rumford Falls, Me., and Hugh K. Moore, Lynn, Mass. App. filed Dec. 27, 1898. The main features are in the use of a vertical diaphragm of non-conducting material, on the outside of which is the cathode, consisting of a mattress made up of a plurality of layers of wire cloth or a bed of steel-wool forming a comparatively thick sponge; and an anode consisting of a plurality of gas carbons cast in a lead supporting plate.

716,833. METHOD OF BREAKING ELECTRIC CURRENTS; W. L. R. Emmet, Schenectady, N. Y. App. filed Aug. 24, 1898. (See Current News and Notes.)

716,844. BATTERY INSTALLATION; S. Lake, Bridgeport, Conn. App. filed May 4, 1902. The battery carried by a submarine boat is placed in a sealed compartment which is fitted with means for discharging gases generated by the batteries outside of the boat and for maintaining a predetermined atmospheric pressure within the compartment without the introduction of external air.

716,848. MODE OF EXTINGUISHING ELECTRIC ARCS; R. H. Read, Schenectady, N. Y. App. filed April 3, 1901. (See Current News and Notes.)